DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. VII, No. 77. MAY, 1926 (Annual Subscription 12s.6d. Post Free). PRICE 1s. NET

NAGA FASHIONS

CONTENTS

DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. VII. No. 77. MAY, 1926. PRICE 1s. NET

Edited by John A. Benn.

Publishers: Benn Brothers, Ltd. All communications respecting editorial matters to be addressed to the Editor: all questions of advertisements and subscriptions to the Manager.

Offices: 8 Bouverie Street, London, E.C.4.
Telephone: City 9852 (6 lines).
Telegrams: Benbrolish, Fleet.

Annual Subscription, 12*s.* 6*d.* post free anywhere in the world. Single numbers, 1*s.* net; postage 2*d.*

Binding cases for Vol. VI, 1925, are now ready. Price 2*s.* 6*d.* net each; postage, 6*d.*

Editorial Notes.

Another English university has been created by the grant of a Royal Charter to University College, Reading, announced shortly after our April issue went to press. Founded in 1892, the college now has about one thousand full-time students and it is suggestive, both in its size and surroundings, of an American rather than of an English university. The buildings at Reading are situated in beautiful wooded lawns, and the Hall, the chief among these, can seat the whole student-body. Across the water the "campus"—or university grounds—is a usual feature of the universities, many of which are also comparable in size to the youngest English foundation; and the conscious unity of the student-body is not so generally characteristic in this country as in America. There, of course, it is largely accounted for by the absence of colleges within the university, the undergraduates being divided instead by seniority; and at the residential universities the dormitories are common to every student, who thinks in terms of the university—Princeton, Harvard, or wherever it be—and not in terms of the college, as is usual, for instance, at Cambridge. In the United States there are some six hundred universities, but as these are scattered over an area equivalent to that of Europe, there is already a larger number in this country, proportionately to area. On a population basis the percentage attending universities is over three times as large in the U.S.A. as in Great Britain. Although American educational standards are, on the whole, lower than those prevailing over here, the opportunity of attending a university is more general; and the extension of such facilities in this country should meet with widespread approval.

* * * * *

The third congress of the universities of the Empire is to be held at Cambridge in July, previous conferences having taken place in 1912 and 1921. One of the most interesting problems to be discussed is the mutual recognition of examinations and of time spent in study elsewhere, a subject that will be introduced by Sir Matthew Nathan, Chancellor of the University of Queensland. The conferment of university status on existing colleges and the foundation of new ones must necessarily be a gradual process, but the time is certainly ripe for serious consideration of the means of bringing about an early extension of the facilities for graduating on the basis of work done at more than one university. Existing arrangements might be broadened not only between universities of this country and of the Dominions, but among the home universities themselves. The time-honoured custom of "migration" in Germany might well be taken into account in the discussion. The scheme was certainly a practical one; it gave the student a broadened outlook; it resulted in a closer understanding among the students of the country as a whole, and it was conducive to co-operation between the faculties of the various universities. Heinrich Heine migrated from Bonn, first to Gottingen and then to Berlin, and although his departure from Gottingen was compulsory—he was suspended for an infraction of the law against duelling, which may have accounted for his opinion of his professors!—his writings give a delightful impression of the advantages of the system as it worked and is now working again in Germany.

This year's meeting of the British Association, following as it does closely upon the Empire universities congress, will doubtless be largely attended by visitors from overseas, and it is noticeable that several subjects of imperial interest are included in the programme. As the preliminary announcement on

another page indicates, the Prince of Wales will assume the Presidency in succession to Professor Horace Lamb, and he is expected to speak on the relations between scientific research, the community, and the State, both at home and in the Dominions.

* * * * *

This month will see the departure of two aerial expeditions to the North Pole. On 15th May an American party, under the charge of Commander Bryd, U.S.N., expects to be ready to fly from Spitsbergen, where it has established its main base. Several flights are planned, the first to place reserve supplies at Peary Land, some 400 miles north of Spitsbergen, whence an 850-mile flight to the Pole and back will be attempted. A monoplane of the Fokker type is to be used, and about the same time a lighter-than-air machine—a semi-rigid airship—will set out for the polar regions with the veteran explorer Captain Amundsen. During the war, which was responsible for the first rapid developments in aerial science, it was thought that passenger transport would become more general than has proved to be the case—although almost every country in Europe is now served by air; but the number of other uses was perhaps hardly anticipated.

* * * * *

A large area of the Amazon has lately been mapped by the American explorer, Dr. Hamilton Rice, who took a small hydroplane with him and flew out over the forests on either side of the river; it is hoped that he will shortly contribute an account of the work to *Discovery*. In archaeological research, also, the aeroplane has proved of the greatest assistance, depressions and other formations that pass unnoticed by the observer on the ground being clearly seen from above. Most widely advantageous, perhaps, are its uses in agriculture and for medical purposes. As described elsewhere in this issue, it is expected that at least half the damage annually caused to the American cotton crop by insect pests can be eliminated by aerial methods. Whereas "dusting" the plants by ground machines is a slow process and largely dependent on the weather, over 300 acres per hour can be treated by the new process. The aerial ambulance has now been introduced in Australia, where the population is so sparse that there is often but one doctor to many hundred square miles of the continent; coupled with the use of wireless, an aerial service is to be worked from some nine principal medical bases. All these developments are of the greatest interest, and while it is unlikely that the air will as yet become a general transport highway—at any rate for heavier-than-air machines—there is almost no limit to the employment of the aeroplane for purposes to which it alone is suited.

* * * * *

The dispute now in progress between the Corporation of the City of London and the Ecclesiastical Committee of both Houses of Parliament over the future of the city churches has revived an interesting procedure associated with historic struggles on constitutional matters. The question relates to the Union of Benefices and Disposal of Churches (Metropolis) Measure, which, in short, proposes to give power to the Church of England to dispose of the sites of ill-attended city churches in order to provide funds for new parishes in the suburbs. The City Corporation urge, however, that as "any church that can be shown to be redundant to the satisfaction of the majority of the inhabitants of the parish" can be dealt with under an existing Act passed in 1860 (and some twenty city churches have been demolished under its provisions) any desirable amendment "should be submitted to Parliament in the ordinary way by Bill, when opportunity will be afforded for full discussion of its merits." The protest further says that such a measure as is now under consideration "raises a grave constitutional question which affects the rights of a large number of his Majesty's subjects."

Following agreement by the Ecclesiastical Committee to report favourably upon the measure, the Corporation proposes to exercise its historic right of sending the City Sheriffs in person to present a petition at the Bar of the House—a right that it alone possesses and that is only exercised in the case of measures affecting the City of London. The Lord Mayor of Dublin at one time had a similar privilege but this has now been discontinued. The procedure to be observed, notes *The Times*, is laid down in the memoirs of Sir David Erskine, who refers to a similar incident in March, 1876:

"The Sheriffs of London brought a petition to the Bar of the House at 4 o'clock. On these occasions the Sergeant-at-Arms stands below the Bar, and, on being called by the Speaker, advances, bowing three times, to the table, where he announces the arrival of the Sheriffs to the Speaker; he then takes the Mace and carries it 'ported' to the door, where he joins the Sheriffs and, on their right, advances with them, bowing to the Bar. The object of the petition having been announced, the Sheriffs and the Sergeant back to the door, bowing as before, where the Sergeant leaves them, and again 'porting' the Mace, puts it back on the table. According to ancient custom, the Sheriffs on this occasion dine 40 members in the dining room of the House at 6 o'clock, and give each of the doorkeepers a bottle of wine."

The present revival of this picturesque ceremony is yet to take place, and it will be watched with considerable interest.

The Wild Tribes of the Naga Hills.

By J. P. Mills, M.A., F.R.G.S., F.R.A.I.

The Naga tribes live in a mountainous tract of country on the Assam-Burma frontier, where the author spent some years as an administrative officer. The Nagas are among the most primitive of peoples, and their manners and customs are of considerable anthropological interest.

FROM the great bend of the Himalayas to the north of Assam a long range of mountains runs almost due south, continuing under the sea to the Andaman and Nicobar Islands, and on through Sumatra and Java almost to Australia. This, and the parallel range which passes through Borneo and New Guinea, has from the earliest ages been one of the great highways of mankind.

A Great Road.

By it it is almost certain that the Aborigines of Australia reached their present country. Many of those who have passed along it have left laggards by the way. In the Andamans we find a remnant of an early Negrito stock, so primitive that when we first knew them they possessed fire, but did not know how to make it. In the Nicobar Islands, too, lives a race which is thought to represent the earliest Mongolians.

But it is not only in the south of this road that the descendants of early travellers are to be found; far away in the north-east of Assam, in the tangle of hills which lie between that province and Burma, dwell the Nagas, one of the most interesting races we know. Much of their country is still unadministered and even unexplored, and one is still able to study there what is now so rare in the world—the untouched savage. Though their origin and composition are still far from certain, it is clear that they are to be classed with the Mongolian races of Indonesia, as this great highway is called, and sharply distinguished from the Aryans of India. The curly hair of some individuals and the small polished stone celts found in their hills, seem to point to the existence of an early Negrito stock which they have absorbed. Their languages, too, are non-Aryan and belong to the Tibetan - Burma group.

A GROUP OF PHOM WARRIORS FROM INDEPENDENT TERRITORY.
The man on the right is wearing full dress, the figure worked on his apron, his boar tushes and shells in his ears denoting that he has taken heads.

Their links with Indonesia are many. The terraced hill-sides of the Angami Nagas have their parallels in the Philippines, Borneo and other places. Mr. Henry Balfour, of the Pitt Rivers Museum, Oxford, has shown that the making of fire with a bamboo thong and split stick is practised all down the line of Indonesia. He has traced, too, a similar distribution of a peculiar conical fish-trap lined with reversed thorns.

Bachelor Houses.

The Naga loom is of the Indonesian type. Their "morungs," or bachelor houses, have a parallel in the "ravi" of New Guinea and similar structures elsewhere. Their slit log-drums or xylophones can be compared with similar instruments found in New Guinea and as far south as the Fiji Islands. The feathers of the hornbill are especially highly regarded, and the bird used as a motive of decoration both in

the Naga hills and in Borneo. The practice of head-hunting has a wide distribution in Indonesia, and the little thorn mallets with which tattooing is done are very similar throughout the whole area. Many of the folk tales, too, are identical, especially that curious myth that the moon once was hotter than the sun, and was cooled by having something thrown at it because its fierce heat was burning up the earth. This story is even found in the Nicobar Islands, for long one of the most isolated places in the world.

The Nagas comprise almost a score of tribes, among

THE CHIEF HEADMAN OF AN AO VILLAGE IN FULL CEREMONIAL DRESS.
The "tail" is the most striking of all Naga ornaments.

the best known being the Kacha Nagas, Argamis, Lhotas, Semas, Sangtams, Changs, Konyaks, Kabuis, and Tangkhuls. They differ much in stock, language and dress, yet possess certain characteristics in common. Their dress is scanty. In some tribes the men go naked; in others they wear kilts ornamented with cowries, but the usual dress is a small apron, with a cloth either of cotton or bark fibre thrown round the body. The dress of the women is almost as varied; in some tribes skirts are worn reaching to the knees; in others the skirts are only about four inches wide, and are more like breeching straps than anything else.

The ornaments of the men are very impressive. Human hair and goat's hair dyed a brilliant scarlet play a large part. In some tribes conical-shaped hats of very finely plaited scarlet cane are worn, and in others a deep fillet of bear's hair in which the black-barred tail feathers of the great Indian hornbill are stuck. The shafts of the feathers are so adjusted that their edges turn readily in the wind. Across the chest is a baldrick—a kind of sash—with a deed fringe of scarlet hair, supporting behind a tail—the most striking of all Naga ornaments—deeply fringed with human hair. Leggings of plaited cane are sometimes worn. Ivory armlets sawn from an elephant's tusk are much sought after for the upper arm, the wrists being decorated with gauntlets of cloth entirely covered with cowries and fringed with scarlet hair. The weapons of the Nagas are a spear and dao—a sharp chopper-shaped weapon—with sometimes a cross-bow.

Feasts of Merit.

The right to wear the highly-coloured and beautifully woven body-cloths in some cases belongs to a man who has shown his prowess in war, but more often is won by lavish hospitality and the giving of a prescribed series of feasts of merit, which play an important part in Naga life. A man begins with a small sacrifice, such as that of a pig, and goes on by certain rigid rules to sacrifice cattle and mithan, or domesticated bison (*Bos frontalis*). Sometimes the expenditure on these feasts—to which the whole village goes—is enormous. One man I know sacrificed no fewer than forty-two mithan on one day. Having performed the mithan sacrifice a man has earned certain privileges. He may build his house in a more elaborate style, again prescribed by rigid rules, and, most valued of all, his name is included among those whose praises will be sung for ever at village festivals.

A Naga's diet is both limited and varied. Certain things are tabu either to a clan or to a sex. But a Naga will eat almost anything which is not tabu. His staple diet is rice in places where it is not too cold for it to be grown, save among the Konyaks where taro takes its place. On the higher ranges millet and Job's Tears—another kind of grain—are eaten, both peculiarly unappetising-looking dishes, but the staple food, none the less, of a vigorous race. With his rice, millet, or whatever it may be, the Naga likes meat or fish if he can get it, and he does not worry about its freshness. If he cannot get meat he will eat boiled jungle leaves, fruits, roots, wasp grubs, spiders, beetles—in fact, anything that can be eaten.

A Naga never drinks water if he can help it. Even when he goes down to a river to fish he takes a supply

THE MAIN STREET IN AN AO VILLAGE.
The low front eave of the hut in the foreground indicates that its owner has given a Feast of Merit.

of liquor with him. This is made from fermented rice, millet, or Job's tears, and is of various kinds. The grain is boiled and spread out to cool on mats. Over it, while it is cooling, yeast is sprinkled and the whole mass is then put into high baskets lined with leaves and the juice allowed to drain through. This juice is the strongest liquor drunk. A weaker kind is made from the grain after this drained juice has been removed. Water is poured on to it and the milky fluid resulting is the ordinary drink.

Irrigation and Agriculture.

Grain being the staple food of the Naga, agriculture fills the greater part of his life. The Angamis have covered the hillsides of their country with a wonderful system of irrigated terraces, all made without levelling instruments of any kind. Water is led round the shoulders of hills and from terrace to terrace with the minimum of loss. Needless to say, the rights to tap certain streams are very valuable, and most of the petty quarrels in villages are concerned with them. This, however, is not the usual method; most Nagas practise what is known as "jhum" cultivation. The villages are permanent, but the cultivation is shifting. Each year the village decides what stretch of hillside of the land belonging to it shall be cultivated. The jungle is felled about Christmas and allowed to dry till March, when it is fired; the ashes are dug into the soil and the seed sown. Harvest begins about September. Fields cultivated one year are used again the next, together with another stretch of newly-felled jungle, these two cultivated areas being known as the "old" and the "new" fields. After two years the land is allowed to go fallow and jungle soon grows up again and covers it. The more land a village possesses the longer it can afford to allow a portion to remain under jungle, the ideal period being about ten years. By that time the old trees which were not cut down have grown strong branches again, and there is a thick undergrowth of bushes with a deposit of mould.

In a Naga Village.

A Naga village may consist of anything from twenty to seven hundred houses. It is situated on the highest point of a ridge. Round it, save where the steepness of the ground makes defences unnecessary, runs a stout fence and a ditch studded with "panjis," bamboo spikes, on which unwary raiders will pierce their feet. In administered districts such defences are now no longer kept up, but in the independent areas even the ground round a village is studded with bamboo spikes so that no one can go through it except

A NAGA "MORUNG" OR BACHELOR'S HOUSE,
with carved tiger on main post and a python on smaller one.

by narrow and easily-defended paths. At its gates are the big " morungs " or bachelors' houses. These are the guard-houses of the village, and are often connected by light cane bridges with look-outs in big trees outside the gates. In these " morungs " the boys sleep and the warriors lounge and chat. A boy enters the " morung " when about eight or nine years of age, and for three years he " fags " for his elders and betters, bringing water for cooking, wood for the fires, making pipes, sharpening daos and a host of other duties.

Marriage Customs.

The system of marriage is that a man must wed outside the group of clans to which he belongs, and with the exception of the sacred clan of the Konyaks this is the invariable rule in all Naga tribes. For a wife he pays a marriage price in kind, which varies much in the different tribes, the highest probably obtaining among the Sema chiefs. The son of a chief is willing to pay a high price for a chief's daughter because the alliance with his father-in-law is a sort of life insurance. Though marriages are arranged by parents and prices are paid, it is not to be thought that girls are sold or forced to marry. Children are usually badly spoilt by their parents. There is no worry about school bills or the choice of a profession, for a boy naturally becomes an agriculturist like his father.

Certain sacrifices are performed at death. They usually include a dog, which is supposed to go barking along the road of the dead ahead of the deceased to warn his relations and forefathers that he is coming. Most tribes bury their dead ; some, however, expose them on platforms. In some tribes they just leave the corpse to fall as the platform rots, while in others they wrench off the head and deposit it separately, after due respect has been paid and offerings made to it. The Nagas usually believe that the land of the dead is placed under the earth, or sometimes in the sky, and is like this world. There a man lives in a village as he lived here, hunting, fighting and cultivating his fields. There again he dies, and after one or more subsequent existences in shadowy worlds, he fades away and ceases to be.

BIBLIOGRAPHY.

" The Naga Tribes of Manipur," by T. C. Hodson.
" The Lushei-Kuki Clans," by Lieut.-Colonel J. Shakespear.
" The Sema Nagas " and " The Angami Nagas," by Dr. J. H. Hutton.
" The Ao Naga Tribes of Assam," by Dr. W. C. Smith.
" The Lhota Nagas " and " The Ao Nagas," by J. P. Mills. All published by Macmillan & Co. on behalf of the Assam Government.

The British Association.

THE preliminary programme of the 96th annual meeting of the British Association, to be held in Oxford from 4th to 11th August, has now been issued. The inaugural general meeting will take place in the Sheldonian Theatre on Wednesday evening, 4th August, when the Prince of Wales will assume the Presidency of the Association in succession to Professor Horace Lamb, and will deliver an address which is expected to deal, among other matters, with relations between scientific research, the community, and the State, both at home and in the overseas Dominions. As the accommodation in the theatre is not expected to suffice, the proceedings will be relayed to the Town Hall, and elsewhere if necessary. The seating in these halls will be allocated according to priority of application, which should be made to the Secretary of the Association, Burlington House, W.1. No technical qualification is required for membership, and the small fee of one pound entitles to attendance at the annual meeting.

Presidential Addresses

The subjects of a number of the addresses by sectional presidents are announced. In the mathematical and physical section, Professor A. Fowler will deal with the production and analysis of spectra ; and spectroscopy is likely to be a principal subject of discussion in this section. Professor J. F. Thorpe will address the chemical section on the scope of organic chemistry, and Professor S. H. Reynolds the geological section on progress in the study of the British lower carboniferous rocks. In the zoological section Professor J. Graham Kerr will speak on biology and the training of the citizen. The Hon. W. Ormsby-Gore will bring the first-hand experiences of his African tours to bear in discussing the economic development of British tropical Africa, in the geographical section. Sir Josiah Stamp will address the section of economics on inheritance as an economic factor. In the engineering section Sir John Snell will deal with the recent and probable future development of the electricity supply. Professor H. J. Fleure, in the chair of the anthropological section, will review the modern position in regard to knowledge of the evolution of human races ; and Professor J. B. Leathes, addressing the physiological section, will deal with function and design. Sir Daniel Hall will address the agricultural section on area of cultivation required to feed the population. Professor F. O. Bower, who succeeds the late Mr. W. Bateson as president of the botanical section, will review the state of botanical science at the present time in comparison with that at the Oxford meetings in 1894 and 1860.

Bacon and His Legacy.

By Hugh B. C. Pollard.

Three centuries have gone by since the death of Francis Bacon, but his challenging message has lost none of its significance. There is now, as then, "a new unexplored kingdom of knowledge within the reach and grasp of man if he will be humble enough, and patient enough, and truthful enough to occupy it."

APRIL marked the tercentenary of Francis Bacon, Lord Verulam, Viscount St. Albans, 1561-1626. As a line in a diary it means little to the ordinary man, yet if we reflect a moment we find that in celebrating this date we are honouring the godfather of all modern science as we know it to-day. Francis Bacon was an enormous influence, a Napoleon of the battlefield of intellectual freedom. No man of his age presents a greater puzzle to historians, and there is a good deal of excuse for the theorists who hold the wildest beliefs about the Bacon-Shakespeare controversy. There was much that was hidden in the man, and the face which Bacon chose to show to the world was not the whole man. An eminent psychologist has dissected the psychical body of Leonardo da Vinci. Francis Bacon would be an even better subject for this kind of post mortem, but it calls for rather more knowledge than pure psychology and some little learning in sixteenth - century mysticism and the political limitations of the time.

FRANCIS BACON, LORD VERULAM.
From an old engraving.

The First of the Moderns.

Bacon was essentially the first of the moderns. He was an organizer, a compiler, an enormous centripetal force who focussed the revolt of the times against the formalized schools of deductive Aristotelean logic. For the unquestioned authority and the petrified wisdom of the classics he substituted the line of thought we still call natural science. He dignified experiment and gave it a new standing as inductive logic. He was the first outstanding intellect in historic times to realize that the function of science was not to repeat the official quips of fossil thought, but to experiment, observe, and see what caused all sorts of things to happen. To-day this seems to us a perfectly reasonable logical idea which should have occurred to anybody.

We all owe so much to Francis Bacon that it is with difficulty that we get any true picture not of the pageantry, but of the mentality of his time.

It is perhaps best to see Bacon as a man of to-day set by circumstance three hundred years before his time. Yet even this device is inadequate, for Francis Bacon had a greater grasp and a deeper knowledge of the spiritual values than is common among the rare philosophers of his calibre to-day.

It was an unsafe age in England. Rome then stood for foreign domination, for the dead hand of priestcraft on all who sought knowledge. Lutheranism was no better, and the extravagances of the Protestant sectaries were just as bad. There is no sanction for natural philosophy in either Testament, and the inquiring and rational mind was a dangerous thing for its owner in those not too distant days when the ashes of those martyred by both sides were barely cold.

New ideas were perilous ideas, and the greater part of Bacon's work had to be done in secret. In open history he stands out as an eminently sound adviser and a poor politician. He had the unforgiveable vice of sincerity of purpose and the colossal hardihood to oppose Elizabeth Tudor. It is true that in his "Essays" he counsels a wise expediency, but a man of his calibre has an exacting judge to satisfy. He must live on honourable terms with himself. A balanced attitude was not a road to favour in partisan times. In addition, he had to counter the jealousy of his cousins the Cecils. The

support of Essex helped Bacon in his career, and the latter has been accused of betraying his patron. His attitude at the trial of Essex was harsh, but to a certain extent excusable. Essex had not taken Bacon's advice, and he had gone far toward a state of insurrection which would have meant civil war. Bacon was an autocratic Tory democrat, but not a revolutionary.

A Wide Toleration.

The whole tendency of Francis Bacon's policy was toward the betterment of the condition of the realm and the people of the realm as a whole. He urged a wide toleration not only in matters of religious belief, but in matters touching oppression by the Crown. Yet he was no democrat and held the divine right of kings. With the accession of James the First he rose to power. Knighted in 1604, he became Attorney-General in 1613. He steered a tortuous way through the difficulties of the times, and evidently became more "expedient" as age withered his idealism. He abandoned the favourite Somerset for the rising star of Villiers, and in 1617 was appointed Keeper of the Privy Seal. A year later he became Lord Chancellor of England, and was raised to the peerage as Lord Verulam.

In 1621 he was at the height of his glory, but Parliament, which had been unconvoked for seven years, was at last summoned, and his enemies attacked on charges of bribery. Bacon fell, and though the sentences of fine and imprisonment were revoked, he was obliged to live in retirement on his estate. Freed of the squalor of politics Bacon now came to his real glory. These last six years of his life were the most important, for he then began to publish the thought of years. He had published a certain amount before. In 1605 he had issued his "Advancement of Learning," a review of the state of knowledge of his time. During his career he had published various "Essays," but the work was continually revised and added to. Few works have given us so many common aphorisms as these "Essays," and new and larger editions were printed from time to time. Yet these, important as they are from the literary point of view, had not the influence on history which was exercised by his scientific work, the "Novum Organum," the greatest stimulant of the age ever given to a group of thinkers.

So much for the external side of Bacon. Industrious historical emmets can trace the record, and it is a not too scrupulous career of the external man. Yet we can ask ourselves what is there in this spotted record which stresses the scientific side of Bacon's life? We see him in history as an able true-serving attorney, a courtier, a man circumstanced by the moral conditions of his age. Yet when we turn back to the fundamental origins of organized science in Europe every road, every line of research leads to one centre—Bacon and his disciples—and there is no clear path which leads us to the individuals who preceded him.

It is doubtful if we shall ever know any particular original contributions to scientific knowledge for which Bacon was responsible. It is better to consider him as an enormous concentrating, classifying and co-ordinating force. He was the first great editor of Nature to arise since classical times; the first administrator to conceive of organized science working for the good of humanity in general. His "New Atlantis" sketches out a model society dominated by brains which would function for the good of humanity. This book was published posthumously, yet we have the authority of Joseph Glanville, Chaplain to James the First, that Bacon did actually found a scientific society of some nature.

The enormous scope of his learning at a time when the range of all the knowledge of the age could be more or less grasped by a first-class intellect could be explained if he had not also led an active career, but had worked as a recluse devoting all his time to study. Even granting the man a mental energy utterly abnormal, we must, when considering the limited mechanism of the distribution of knowledge and the slow time factor for the dissemination of thought, look on him not as an individual but as the head of a widespread intelligence service.

The Rosicrucian Society.

A great many indications point to Bacon as a leading character in the Rosicrucian Society. His "New Atlantis" is modelled on the conceptions of the Rosicrucian Society, and in 1660 was reprinted under the nominal authorship of John Heydon as "Voyage to the Land of the Rosicrucians."

The Rosicrucian Brotherhood has the usual claims of esoteric societies to Egyptian origin. Actually it is difficult to trace any sound historical basis beyond the latter half of the fifteenth century. It may be looked on as an intelligent society accepting the Christian ethic, but equally hostile to political oppressions and corruptions of the Catholic Church and the intellectual savagery of Lutheranism. The probable reason for its insistence on Christianity was that most of the scientific and philosophic knowledge outside the sterile bounds of monastic thought was Oriental. It was either from Arabian sources, as in the case of alchemy and algebra, or it was Kabbalistic and derived from Hebrew thought. We know now that much then attributed to the Moslem was the relics of classical knowledge, and that most of their

work was translated and adopted by Rabbinical writers. Nevertheless, in the days when accusation of heresy was the portal to a painful death and to be suspected of knowledge stirred the jealousy of the official priestly trades union, it is obvious that any search for knowledge required an adequate "safety first" insurance. To the adepts of the society the rose has always been more important than the cross, yet if they secretly eschewed orthodox mass theology and hated sectarianism, they were no worse than the modern man of science who imposes on himself a Christian rule of life and finds it not impossible to accept spiritual values as laws as binding as the laws of science. But in those days they had to be careful and above all secret. Any identification of the newly-awakened desire for knowledge of Nature with any of the new sects would have brought the movement into conflict with the powerful political machine of the then reactionary Church.

The Renaissance set men's minds working, the European Reformation gave certain countries an advantage in being able to permit primitive research work to go on without political interference. The Rosicrucian fraternity has never had fixed constitutions, but has at certain times developed a working organization or international mechanism. The first published florescence of the society reached its height in the early seventeenth century. There was a recrudescence of activity in the mid-seventeenth and in the mid-nineteenth century, and the society still exists as a nucleus organization. It has nothing whatever to do with the various spurious Rosicrucian organizations run by the theosophists or charlatans, and is still a secret society in the true sense of the term.

Bacon was not only the head of the society in England but was in close touch with all continental chapters as well. The light of his intellect illuminated many centres of thought. Reform was necessary not only in the domain of the Church, but in the realm of politics and science as well. Bacon and his helpers were all part and parcel of an organized and inspired evolutionary but not revolutionary movement. Andreae, author of the "Chymische Hochzeit Christiani Rosenkreutz," was one of the leaders in the younger generation of the movement. About 1614 the "Fama Fraternitas," the first public communication of the order, appeared. It was anonymous and appealed to the savants and men of science of Europe. Its authorship is still in dispute, but it served to bring out into the light of day a movement and a widespread system of thought which had been previously secret or so carefully disguised as to be only recognizable by initiates. The wide scope of the profession of faith clause in the Fama was highly unorthodox. It was too wide for the Catholics and too wide for the Lutherans. It led to wild attack and equally wild defence and reckless pamphleteering by both sides, but it was good publicity. John Komensky, alias Comenius, 1592-1671, was received into the order. Baruch, Spinoza, Descartes, and other great men of the seventeenth century were also powerful supporters of Rosicrucian thought, but it is in England that the speculative and philosophical side gave place to the practical result of the restoration of science and the cult of natural philosophy.

[*By courtesy of Cambridge University Press.*
UPPER FLOOR OF THE GATEHOUSE RANGE, POLESWORTH ABBEY,
which "conjecturally may have been the very scene of Shakespeare's schooling."
(See page 186).

There were two sides to Bacon's philosophy: the purely abstract philosophical view, and the natural or experimental—what we call to-day the scientific point of view. In the same way there were two main schools of thought in the Rosicrucian fraternity. On the one side were the mystics soaked in the search for Kabbalistic secrets and esoteric mysteries; they wished to keep their knowledge secret. On the other side we find the exotericists, men of science anxious for demonstrable knowledge and realizing the need of publicity.

The Invisible College.

A generation passes after Bacon. The gap is filled to a certain extent by Robert Fludd, a contemporary, but who was solely an exponent of the exoteric side. Then comes Robert Boyle who, largely influenced by Fludd's teachings, founded in 1645—after the latter's death—the Invisible College. This scheme was designed to put into practice the idea of a college of scientists as outlined in Bacon's "Nova Atlantis."

The college was to be essentially a secret organization of intellectual people and was to be, in spite of the turmoil of the times, above politics and (what was then much the same) variant religious views. The connexion between Bacon's concept and Boyle's college is evident. In a few years it became possible to drop the secrecy postulated in the idea of the Invisible College and the society became public as the Gresham College. In 1660 it became the Academy, and in 1662 it was raised by Charles II to its present status as the Royal Society.

Connexion with the Royal Society.

The early detailed history of the Royal Society is not particularly clear, but it is clear that it is in direct connexion with the exoteric half of Bacon's original conception. We find in association with it not only Boyle, but Sir Christopher Wren, Sir Robert Moray, Elias Ashmole and Locke. These are also not only the most important names in the early Royal Society, but also in English Freemasonry. Sir Robert Moray, who was the driving force behind the Royal Society, had entered the Rosicrucian fraternity in 1641, and was also the driving force in Speculative Freemasonry. Prior to this period we have no satisfactory trace of any Masonic organization other than purely operative or guild concerns. There is no trace of any persons of quality in association with these minor guild mysteries, yet between 1630 and 1660 we find people of social eminence—and it was a day when social caste rules were binding—enrolled in Masonic organizations.

The balance of evidence suggests that there is a very strong connexion between the early history of the colleges which eventually became the Royal Society and the early history of English Freemasonry. The Bacon tradition had been handed down in full and successfully in so far as the exoteric or scientific side of his concept was concerned, but the inner secrets of his philosophy—the esoteric teaching of Rosicrucianism—this had not been transmitted. The scaffolding of symbolism remained, bits and pieces of the tenets, ideas, suggestions—but not the all essential clues. The secrets had been lost.

The best brains of the time set to work to recover what could be recovered of the tradition. Freemasonry was a popularized version of what could be gathered. It had a secondary potential purpose. If the times had changed again and science had once again been outlawed, the tradition of scientific work could have been kept alive under the cover of the Craft. The chief executive authorities of the Royal Society and of Freemasonry were at that time one and the same individuals. We can imagine the enthusiasm inspired by the widening of knowledge in science, and the natural assumption that Bacon's wisdom—which had borne such fruit in the realm of natural philosophy—would yield no less on the mystical side. It is probably more than coincidence that Sir Isaac Newton (who was not an original member of the Royal Society and who did not become a member till 1672) worked for some years at Kabbalistic researches, and is believed to have in the end destroyed the results of his labour.

Establishment of Organized Science.

There are endless mysteries about Bacon. His parentage is attributed to Elizabeth Tudor; he can be proved by true believers to have written Shakespeare's plays, Cervante's Don Quixote—and almost anything. Massive structures of most sedulous error have been reared on matters of biliteral ciphers, of water marks, of type founts in his books. His date of death and place of burial are none too well established, and altogether he is a puzzling individual. Yet if we reject the wildest and most entertaining theories it is difficult not to find some excuse for sympathizing with the people who believe in them. Bacon's work had to be done in secret according to the need of the times and the rule of the order of which he was a member. His work led to the establishment of organized science and the foundation of the Royal Society, the first official body of its kind to be founded in Europe. It also led to the establishment of Speculative Freemasonry. To-day both these great things radiate all over the world. The man of science and the Freemason alike should give honour to the man whose work three hundred years ago gave expression to concepts of freedom of thought, tolerance, and clear thinking, which were then three centuries before their time, and have been only generally accepted by the world during the last three generations.

The Properties of Catalytic Action.

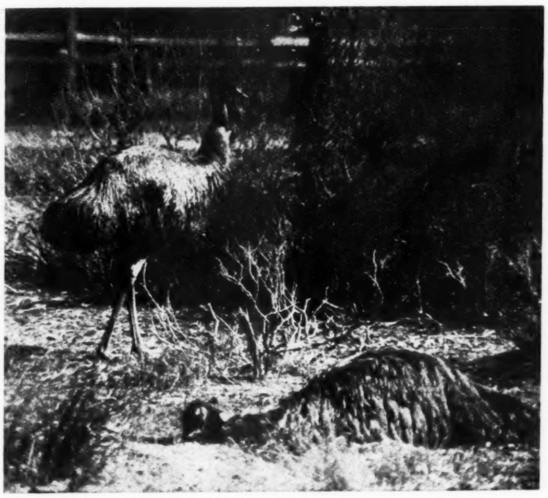
An explanation of the activity of catalytic agents in chemical reactions has just been advanced by Professor H. S. Taylor, of Princeton University, U.S.A. Experiments with gases on these agents, which accelerate chemical activity, suggest that the most efficient of the atoms composing the catalyst change the reacting gases from the molecular to the atomic condition. It is reported that nitrogen atoms have been shown to be present when an iron catalyst is exposed to gaseous nitrogen in the molecular state, and the theory is further supported by a claim that the introduction of small amounts of oxides act as "supports" to the catalyst.

Researches on the Breeding Factor in Birds.

By C. J. Patten, M.A., M.D., Sc.D.
Professor of Anatomy in Sheffield University.

Nearly all the springtime habits of birds are part of the elaborate practice of courtship and breeding. Song, pugnacity, and display are only a few of the factors in the procedure, as Professor Patten shows in this fourth article in the series on the habits of birds which he is contributing to " Discovery."

HAVE you ever watched a bird, say a common house-sparrow, making love? If not, you have missed an entertaining and instructive spectacle. His pleasing subtlety, his persuasive rather than coercive



[*Photo from life, at Adelaide, Western Australia, by C. J. Patten*
AUSTRALIAN EMEUS.
The male is seen incubating, his whole body prostrate, with outstretched neck and beak touching the ground. Betimes he has to ward off attacks on the chicks by the female, who parades round with a dignified and masterful air.

measures, his sedulous display of plumage, his vanity of deportment, his love-antics and dances, his vocal lyric and other charms, earn for him, as he plights his troth, the name of a gallant little gentleman, who after clash of arms with his rival suitor shows good-will. His expectant mate is a lady of discrimination; she is prone to exercise a considerable power of choice—indeed, becoming at times quite fas idious—before setting her seal to the bonds of wedlock. These remarkable characteristics, in their association with courtship, go hand in hand with remarkable anatomical and physiological features.

Highly Specialized Creatures.

In the countless ages representing the stem-history of evolution, birds, in emerging from a common ancestry with reptiles, branched off not only from the main stem, but also widely from their reptilian cousins. Hence extant reptiles and birds are in many ways strikingly dissimilar. In birds, which are highly specialized creatures, we find that the blood is richly oxygenated and considerably hotter than the blood of mammals.

The Fire of Life Aglow.

The body temperature in some species reaches to 110°F., and is usually at least half a dozen degrees higher than in mammals. Circulation, respiration, digestion, and excretion, are very active and rapidly performed. The fire of life is all aglow; combustion is so rapid that food must be taken frequently and abundantly. Incessant search for food brings birds out on the open; hence in eluding many enemies they have learned to sharpen their wits and to grow watchful on all occasions; in this direction they have been afforded protection through their wonderfully keen eyesight, nd we shall see presently that the visual sense in birds plays a very important part in the *rôl* of courtship. The bones and muscles concerned with the mechanism of flight are exceedingly powerful; wing-action—often amazingly rapid—is perpetuated during the greater part of the day. Air-sacs permeate the body and lend a powerful aid in respiratory and

[*Photo from life, at Adelaide, Western Australia, by C. J. Patten.*
AUSTRALIAN HERON.
In courtship this bird is not demonstrative, but parades on his long legs before the female in a stately fashion.

vocal mechanism. The vocal apparatus itself, viewed anatomically as a musical instrument, has reached the acme of perfection, and is more intricate than that of any other class of animal.

From the foregoing facts it can readily be deduced that, temperamentally, birds are full of vitality, very emotional, highly-strung, incessantly active and vociferous, indeed, many species are musically loquacious. Their manners consequently have become curiously vivacious, cheerful, and pleasing. These features are clearly indicated in all the vital functions, and particularly so in matters pertaining to breeding.

Love and Courtship.

As a result, birds are amazingly amorous and excitable when under the sway of love and courtship. But a deeper and more fundamental reason is required to explain more fully why it is that mating is such a prolonged and an elaborate affair ; why the males are so extraordinarily pleasing, subtle, and seductive (their polite behaviour offering a marked contrast to the ruder mannerisms observable in the courtship of mammals) ; why love is so very aesthetic ; how the female has become endowed with the taste for the beautiful, and with the faculty of appreciating various colours ; and from whence she derives her powers of preference when selecting a particular male from among several ardent suitors ?

In order to throw some light on the above questions, I must touch briefly upon certain characteristics of some of the physical senses as they occur in birds. The sense of smell is but feebly developed. It is obvious that a scent " track " or " trail " could hardly be maintained for any distance during flight ; odours would be too readily diffused and easily lost by currents of air ; hence the male when wooing his mate tries in the first instance to entice rather than run her to a standstill, the latter procedure being adopted in the courtship of mammals. Here the value of the power of voice comes into play ; musical sounds—uttered by a great many species—carry a long distance, and so the female stays her flight and hearkens with rapt attention to the passionate melody of her suitors. Then, after deliberation, she selects the favourite vocalist. The sense of hearing has a peculiar value in its bearing upon courtship which is decidedly advantageous. Location of sound is remarkably correct ; focus of the exact spot is almost instantaneous. Therefore courtship, in its earlier phases, can become keenly responsive, and can proceed apace, even when foliage and other cover occlude from view the mating birds. However, all further developments, which indeed involve the major parts played by mating birds, such as love-antics, dances, " display " of decorative plumes and other ornamentations, depend for their success upon *uninterrupted visual impressions.*

Here the sense of sight strikes the all-dominant note in the *rôle* of courtship. Birds are not only endowed with extremely keen and penetrating sight but, what is much more remarkable, they are gifted with *keen perception of form and the faculty of appreciating colour.* Birds are critical discriminating observers, and all other physical senses pale before their stupendous sense of vision. Sight, indeed, is the mainstay of the bird's brain ; the sheet-anchor of its life. In short, birds are endowed with an " eye-brain " just as a dog is endowed with a " nose-brain." Practically all day long, in the incessant search for food and in the discharge of other functions, birds use their eyes to their utmost, now making observations near at hand, now afar off, now up, now down ; whether resting or flying they are wont to view their surroundings often in vast perspective. Hence they become visually impressed with the forms and colours of multifarious objects, and of the lights and shades of the earth, sky, and sea. Is it any wonder then that birds have become aesthetic and can show a taste for the beautiful, and can evince strong likes and dislikes at first sight ? Is it any wonder that love-antics, dances, and sedulous " displays " of gorgeous plumes and other ornaments by the male, should stimulate the " eye-brain " of the female and call into action her discriminating powers when making her choice of a suitor ? Indeed, it would be unreasonable to suppose that the subtleties and elaborations, so characteristic of love and courtship, were other than closely correlated with a highly evolved and perfected visual sense, and this all the more so in gaily-plumed non-singing birds where the auditory sense is called into much less account and where the sense of vision exercises in courtship almost its sole prerogative.

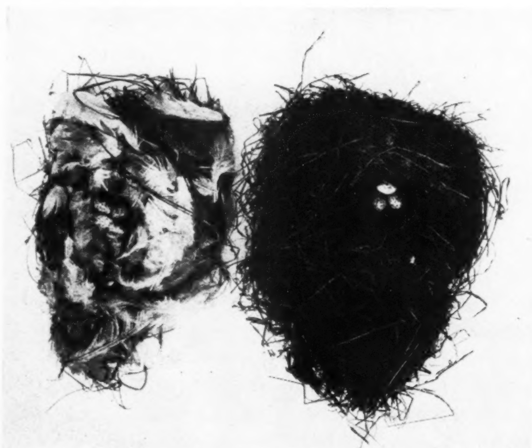
The Season of Battle.

I now propose to touch briefly upon some of the more general features associated with the breeding factor. In the first place, pugnacity. With the males, and in exceptional cases with the females, the season of love is the season of battle. Nevertheless, casualties are usually low. The polygamous ruff enters into combat at the slightest provocation, but his sparring is so o'ershadowed by his grotesque antics that it becomes almost pantomimic in character. Only a minority of birds possess special armour. A few species among plovers and geese are provided with wing-spurs. Some gallinaceous birds, *e.g.*, the domestic fowl and the pheasant, are armed with leg-spurs.

Combats here betimes are serious. The tiny humming-bird is a veritable demon when aroused. He attacks his rival in the air, and his onslaughts are swift and sudden. The intruder when beaten darts like an arrow to his rightful territory, but the conqueror for some time afterwards keeps a sharp look-out in anticipation of a second invasion. Humming-birds in close grips become perfect little furies! They may inflict fatal wounds; they make for each others' eyes and are also said to seize hold of each others' beaks and then whirl round and round till they almost come to earth. I have seen two ruby-throated humming-birds engaged in a combat in the air, but they were for the most part pecking furiously at each other rather than holding on. The robin is a notorious fighter. Apart from rivalry in courtship he will spar on the slightest pretext. Not long ago I walked up leisurely and "arrested" two sparrows; they were so intent on their quarrel that they were quite oblivious of my presence; doubtless they must have been astonished when they found themselves prisoners in human hands!

Elaborate Dances.

Love-antics and dances, which in a large measure are associated with pugnacity, may next be considered. They are highly elaborated in polygamous birds. The familiar blackcock affords a good example. When courting he will rapidly alter his deportment of pride and dignity to that of abject humility. With uplifted head, wings spread, tail raised and fanned, and general plumage ruffled, he will bounce now to the right,



NESTS OF THE HOUSE-SPARROW, SHOWING VARIATION.
Left.—Nest profusely lined with feathers, which are also interwoven through the walls. It was built in an old wall. Right.—Nest composed of hay and built in a lime-tree.
[Photo from nature, by C. J. Patten.

FAMILY OF BARNACLE GEESE.
The parent-birds, with outstretched necks, are hissing menacingly at an approaching canine intruder.
[Photo from life, at Dublin, by W. D. Latimer.

now the left, now in a circle. Then of a sudden he will prostrate himself and press the under part of his throat on the ground, all the while moving in a circle and beating his wings! In this manoeuvre he speeds up and soon appears frantically excited. When other males appear on the scene sparring begins. All these activities are carried on for several weeks, apparently with the view of charming the females. The latter usually keep near at hand, though, as I have seen them, they are sometimes hidden partly from view by the surrounding foliage. When the vanquished males are driven off, the females, drawing closer, select the victorious warriors. The love-antics and dances of many male birds are quite amusing owing to the ludicrous attitudes assumed. In some species, however, the males are cool and rather impassive; the heron, for instance, parades on his long legs before the female in a stately fashion! What a contrast to the fitful flutters of some of our small songsters which pay court to their mates on "wings of love."

Plumage and Decoration.

"Display" of the plumage and of other decorations, which is associated with love-antics and dances, is another familiar feature of the breeding factor. Decorative ornaments, apart from the ordinary complements of feathers, are highly diversified. Not only are plumes rendered beautiful by their great size, brilliant coloration, special texture, shape, and arrangement, but also fleshy and bony appendages adorn several species. The manner of "display" varies widely in accordance with the ornamental endowments of the male. Curious sounds are often produced during "display." For instance, when the peacock erects and fans his gorgeous tail-coverts he

rattles his quills; likewise the turkey-cock scrapes the ground with his wings, producing thereby a buzzing noise. The snipe, in swift descending flight, spreads his tail-feathers and owing to the peculiar architecture of the outer ones, when allowed to rotate, the passage of air through them produces a "drumming" or "bleating" sound. All these sounds—only emitted in association with courtship—are analogous in purport to song, and therefore may be reckoned as "instrumental" music.

The Charm of Song.

But voca sound, in a large measure musical, is a more dominant feature of the breeding factor, and is also closely bound up with pugnacity, love-antics, dances, and "display." Vocalizing may be brought about by the distension of air-pouches appended to the throat. The deep rumbling or booming sounds, produced in this manner in the bustard, the emeu, and some grouse, are accompaniments to indescribably grotesque attitudes. In many of our small sombre-plumed birds, however, where melody has reached its sweetest pitch, it largely supplants the above features. Song, no doubt, charms the female, but it also signifies a proclamation of rightful territory, and warns the rival suitor to keep within bounds. The faculty of song is an important adjuvant in courtship; the attention of the female can be arrested when she is still at a distance, a very necessary matter in the case of creatures which pass so swiftly and frequently through the air. Musical utterances by birds carry an extraordinary distance, and no doubt when sounded prevent birds from becoming separated or perhaps isolated to a dangerous degree. In all these phases of the breeding factor the female plays her own important part. She eagerly watches the males engage in gladiatorial tournaments; she watches the love-antics and dances and pays very close attention to the proper manner of "display." There is no doubt that she is discriminating and will choose the most beautifully plumed males, betimes even when not victorious in combat. Indeed, beauty may be better than battle! Certainly the possession and "display" of ornamentations must prove to be an all-important asset to the wooing males. Again, where song almost overshadows the other features of the breeding factor, we find that the female is influenced not only by beauty of melody alone, but also by vigour and passion, and, in a measure, by elegance of deportment. In my aviaries I have seen the female apparently spell-bound when listening to the song of an all-round first-class performer.

Taste for the beautiful manifests itself also in nest architecture. Many familiar birds—for instance, the long-tailed titmouse and the chaffinch—show decorative art in the manner in which they insert pretty constituents on the outside wall of their neatly-built nests. This taste is very highly developed in the Australian bower-birds. Their "bower," which is erected on the ground, is a "Hall of assembly" or "Nuptial porch." The ordinary nest is built in a tree. A "bower" may reach four feet in length and two in height; round smooth stones are used to keep the grass-stems tidily in position. Prettily-shaded blue or green feathers, delicately-tinted shells, brightly-bleached bones, and other conspicuously-coloured objects are utilized for decorative material. The male, when courting, will carry in his beak one or other of these decorations, more usually a gay-looking feather or leaf; then he will run round the "tent of love." Suddenly he will drop the object in front of the female, but as suddenly picks it up, and away with him again round the bower and in and out through the vestibule, all the while growing frantically excited.

Fond Parental Care.

When settled down to wedded life, the fond parental care of birds is familiar to everyone. The enemy, irrespective of size, is so vigorously and fearlessly assailed that the life of a parent is not infrequently sacrificed. Catering for the voracious offsprings goes on untiringly all day long; we wonder how the parents manage to sustain themselves! Nor do the duties end here; the nests are kept sanitary. Excrement is very frequently removed, and this is no light task. Lastly, benevolence, in association with the breeding factor, has not been found wanting. Cases are on record, some of which have come under my personal notice, where birds of earlier broods revisited the "cradle" to lend a help in catering for their infant brothers and sisters.

British Museum Pictures.

THE Department of Prints and Drawings of the British Museum has lately been presented with two hitherto unknown drawings by Holbein. The finest of these is a small portrait of a young man, of the early Basle period of the artist, about 1520, drawn with the brush on vellum, with the background painted red; the other is a little decorative composition containing three Old Testament subjects in a Renaissance frame. These drawings at one time belonged to Thomas Kerrich, librarian of Cambridge University, who died in 1828, and have since remained unknown.

The Roman Coastguard Stations of East Yorkshire.

By R. C. S. Walters, B.Sc.

Excavations now in progress at Scarborough, on a site bombarded by German cruisers in 1915, have revealed the remains of another Roman coastguard station in Yorkshire, and afforded new evidence of the extensive protection of the coast during the Roman occupation of Britain.

It is of great interest that a Roman signal station, as well as the foundations of Saxon and Norman churches, with the ancient Well or Holy Well of Our Lady, was discovered at Castle Hill, Scarborough, last year. The discovery was brought about by the excavation now in progress on Castle Hill, on the site of the coastguard station damaged in 1915 by the German bombardment.

Castle Hill.

Briefly, about A.D. 350 the Romans built a signal station on Castle Hill, where there had already been a British settlement, and very probably they derived their water supply from this Holy Well. The coastguard station was to keep a watch on the "Saxon shore" against German raiders. About 410 the station was destroyed by Saxons, and the site very likely lay derelict for four or five hundred years. At the end of the tenth century a Saxon church was built not far off, with a churchyard bounded by the old Roman wall. This church was probably burnt in 1066. Between say 1150 and 1170 the whole of the Castle Hill was taken into use, the castle, the walls, another chapel (on top of the signal station and Saxon church and dedicated to St. Mary), being all built in stone. In 1313 this chapel was in its turn destroyed by the barons who were besieging Piers Gaveston. By 1358, a third church arose which was converted into a dwelling-house after the Reformation. This house, in its turn, was demolished after the Civil War and the site lay waste until about 1883, when the Admiralty erected the coastguard station, quite by chance, on exactly the same spot as the old Roman tower. It was this that was damaged in 1915, and future historians will guess that the Germans were guided by traditions of the old signal station of the "Saxon shore"!

Fig. 1.
"OUR LADY WELL,'
in foreground, with (1) foundations of Roman wall of signal station; (2) foundations of Norman chapel; (3) foundations of dwelling houses, erected after the Reformation.

The Lady Well that has now been unearthed was probably built in its present form at the time of the first Norman church in 1150. It consists (Fig. 1) of a circular structure about four feet in diameter of rough hewn stone, fourteen feet deep, and containing about four feet of water. It lies to the south-west of the foundations of the old Norman church, and is not very far away from a mediaeval water cistern which has hitherto been always called the Lady Well. The newly-discovered well can best be seen from an elevated platform that has been erected for visitors to get a bird's-eye view of the excavations.

It is an interesting fact that water is found quite near the surface at Lady Well, whereas at the castle, 150 yards away, a well was sunk for a depth of 170 feet without finding water. This may be accounted for by supposing, what is likely enough, that a patch of clay underlies a stratum of gravel near Lady Well, such clay being absent at the site of the Castle Well.

An Interesting Superstition.

Or perhaps the demands for water at Lady Well were not so great as those at the Castle Well. Whatever may be the reason, however, the fact that water was only ten feet from the surface at the Lady Well of the Chapel of St. Mary gave rise to the superstition that the water had miraculous powers and medicinal properties were ascribed to the waters by "the faithful."

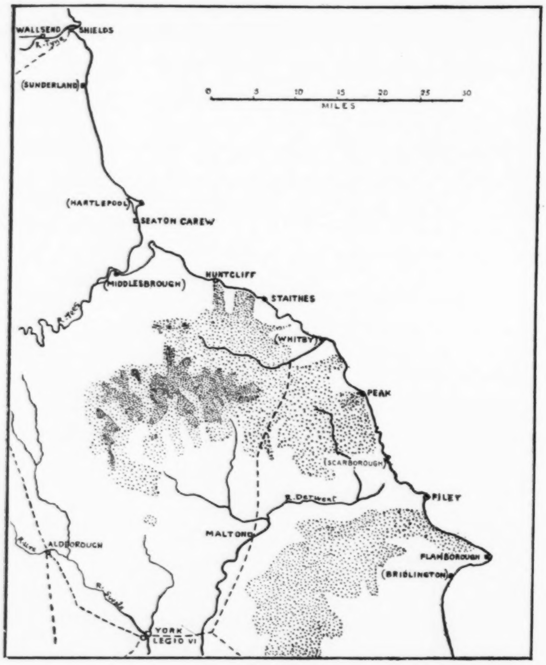


FIG. 2.
SITES OF ROMAN COASTGUARD STATIONS ON THE YORKSHIRE COAST.*
From Professor Haverfield's paper of 1912. Probable sites are indicated in brackets, and the map shows that he foretold the correct position of the newly-discovered station at Scarborough. The shading denotes high ground.

The Castle Well is one of the "sights" for all visitors to the castle; as it is some six feet three inches in diameter and 170 feet deep, the construction must have been a big undertaking. Various mosses and ferns grow in the crevices of the stone lining. It is, unfortunately, covered by an ugly wooden top, but as this is falling into decay it will no doubt be soon replaced by a more suitable structure.

An Old-time Map.

Mr. Herbert Richardson, of Scarborough, kindly called my attention to a plan of Scarborough believed to have been made in 1485, in the time of Richard III. This map shows Lady Well clearly, with a sketch of an open or "draw" well and a long lever balanced on a central fulcrum. At one end of the lever there is a rope going down the well, and at the other end, above the ground, there is a heavy weight.

Although Lady Well appears to date from the Middle Ages, it seems certain that the Romans, in the fifth century, had a water supply there; for at the parallel signal station on Huntcliff, near Saltburn (discovered in 1911-1912), there is a fine example of a Roman well.

The Count of the Saxon Shore.

Visitors to Scarborough Castle will be well advised to purchase the pamphlet sold there on the Roman signal station, by R. G. Collingwood, published in 1925. We may here quote from this, and from the papers of Professor Haverfield in the *Journal of Roman Studies*. About the end of the third century, the "barbarians"—Teutonic nations, Germans—were attacking the Roman frontiers on the Rhine and the Danube in vast hordes; similar but lesser swarms were attacking by sea the outposts of the Empire, that is, at first the north of France, then the south coast of Britain, and then the east coast. For the protection of Britain Diocletian established an officer called the "Count of the Saxon Shore," who had under his charge some nine forts situate at intervals between the Wash and Beachy Head (or perhaps Portsmouth). In the fourth century an extension of the defence

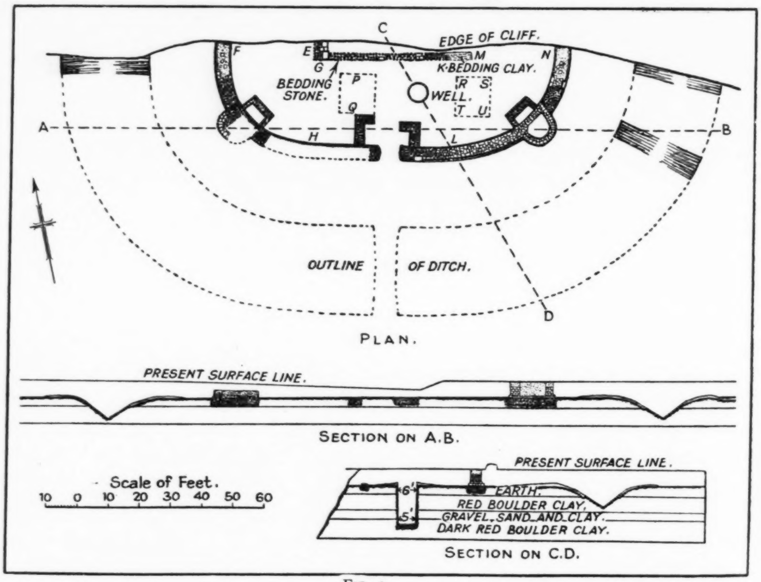


FIG. 3.
PLAN AND SECTION OF ROMAN FORT AT HUNTCLIFF, NEAR SALTBURN.
More than half the fort has fallen over the edge of the cliff. Note the boundary-wall with bastions, and the well in which many remains were found. The ditch in front is conjectural.

*The author is much indebted to the Society for the Promotion of Roman Studies for the use of Fig. 2, being reprinted from Prof. Haverfield's paper (*Journal of Roman Studies*, vol. 2, pp. 205-209); and Figs. 3 and 4, from the paper of Messrs. W. Hornsby and R. Stanton (*ibid.*, p. 216).

for the coast was necessary, and several signal stations were built along the North Yorkshire coast. These were strong enough to resist small bands of raiders, but were primarily meant for giving warning, unlike the stronger forts, accommodating 500 men or so, of the south coast.

An Interesting Prophecy.

There were probably stations on the Lincolnshire coast, but so far no traces of their remains have been found. Similarly, along the Holderness coast, from Spurn to Flamborough, there undoubtedly existed such structures, but these would have disappeared long since owing to the encroachment of the sea in this region. In Yorkshire (Fig. 2), the most southerly point where it is probable that there was a coastguard station, is Flamborough Head. At Carr Naze, near Filey, eleven miles farther north, there were abundant Roman remains on the edge of the cliff, discovered in 1857, certainly giving sufficient evidence to indicate the presence of a station. Again, seven miles farther north, is the newly-discovered fort at Scarborough, of which Professor Haverfield prophesied in 1911, "Hints of such an intermediate station have been noted near Staithes and *we might also look for them on such a hill as that of Scarborough Castle,* and on the promontory of Flamborough, though the one is only seven miles north of Filey and the other only eleven miles south of it. No Roman remains seem to have been found at Flamborough, while at Scarborough they are limited to a very few coins and potsherds found, be it noted, not on Castle Hill, but on South Cliff." The recent excavations have produced several Roman coins dating as late as A.D. 370 on Castle Hill.

Nine miles north of Scarborough there is very definite evidence at the Peak, near the Ravenscar Hotel, overlooking Robin Hood's Bay, which was brought to light in 1771; a Roman inscription was found saying: "Justinianus the Commander . . . praefect of soldiers built this fort." (possibly in A.D. 406).

Again, another twelve miles north of the Peak there is evidence of another "fort" at Goldsborough, near Staithes and lastly, ten miles beyond, there are the excellent remains of the Roman signal station at Huntcliff, near Saltburn (Fig. 3) discovered in 1911-1912, with the Roman well, the contents from the latter when cleaned out giving valuable information concerning the history of the Huntcliff station.

FIG. 4.
PART OF THE ROMAN COASTGUARD STATION FOUNDATION AT HUNTCLIFF, SHOWING THE SOLID NATURE OF THE ROMAN WALLS.

From the evidence of the Scarborough and Huntcliff remains, and from the representations of these structures on the Trajan and Aurelian columns, we may imagine that a typical Yorkshire signal station consisted of a courtyard, 110 feet square, bounded by a wall (Fig. 4), say twelve feet high, with rounded corners and with a bastion projecting from the middle of each corner. The entrance was on the landward side. In the centre of the courtyard was the look-out tower with a stone and wooden superstructure. Fire and smoke

BIBLIOGRAPHY.

Prof. Haverfield.—"Notes on the Roman Coast Defences of Britain, especially in Yorkshire." *Journal of Roman Studies,* vol. 2, p. 201. (1912).

W. Hornsby and R. Stanton.—"The Roman Fort at Huntcliff, near Saltburn." *J.R.S.*, vol. 2, p. 215. (1912).

F. G. Simpson.—"Scarborough Excavations."

R. G. Collingwood.—"Scarborough Excavations." (Pamphlet).

R. G. Collingwood.—"The Roman Evacuation of Britain." *J.R.S.*, vol. 12, p. 74. (1922).

R. C. Hope.—"Holy Wells of England," p. 195. (1897).

M. V. Taylor and R. G. Collingwood.—"Roman Britain." (1921-2). *J.R.S.*, vol. 2, p. 203.

and probably the semaphore were the warning-signals used on the approach of raids. At Scarborough there is evidence that the station was destroyed by fire; at Huntcliff the garrison was apparently slaughtered, many skeletons being found in the Roman well there.

The Corporation of Scarborough is taking an active interest in its newly-discovered historical treasure on Castle Cliff; it has reburied the skeletons that were found during the progress of the excavation, and consecrated the ground by a stone slab, bearing the following appropriate inscription:—

"Here lie the remains of many Christian people interred during the Middle Ages in the graveyard of the Chapel of Our Lady which occupied the site of the Roman signal station. Their remains were removed to this spot during the excavations, 1921-1925, at the request of their successors in the Common Faith of Jesus Christ as Saviour and Lord. This memorial was erected by the Corporation of Scarborough."

Animals and the Spread of Disease.

A New Danger Suggested.

It is well known that animals are carriers of disease, but recent research suggests that new dangers may be attributed to their agency. Certain organisms giving rise to one form of disease in animals are now thought to produce another form in man, and this opens up immense possibilities of combating hitherto unsuspected sources of disease.

It was Darwin who remarked that the commonest animal in the world was the mouse; at any rate, there are a very large number of mice—far more mice than there are men. Man is but one animal, one species of animal, in a world teeming with animals. With many of his fellow-creatures man lives, by choice or accident, in intimate relationship. He is clothed in animal skins and furs; he eats animal flesh and drinks animal milk; of necessity he must breathe the same air as they do, and his ways must cross theirs in a hundred unexpected and unrealized places.

Man has, in fact, enslaved the whole animal kingdom to his great advantage; but he has paid for it. Undoubtedly many of the world's diseases are spread by and contracted from animals, and it is very doubtful that the sum of these diseases is yet realized.

Probably the classical example of disease spread by animals is plague. Rats were associated with plague in the days of ancient Assyria; mediaeval Italy knew that when rats started to die in numbers plague would break out; and to-day we know that plague is a disease of rats spread by fleas to man.

Rat-bite Fever.

Rats, therefore, suffer from one grave disease which may be contracted by man; and rats have many opportunities of crossing the paths of men. They abound in granaries, and nibble his food—there must always be a risk of the contamination of corn and other foodstuffs by their excreta; and there are other diseases, too, which they can carry to man. "Rat-bite fever" is a form of grave jaundice, due to a parasite known as a spirochaete, which was first recognized following the bite of a rat. But now it is being recognized in miners, and the contamination of water in mines by the excreta of rats is believed to account for it. It has been recorded, too, in dockers who have fallen into filthy water, where rat excreta must abound. And—though, surprisingly enough, the public press has not drawn attention to the matter—not long ago a medical paper published an account of the discovery of the organism of rat-bite fever in "pure" London tap-water.

Unexplained Diseases.

The disease is a rare one; evidently, if the organism be common in London drinking water, some factor is lacking which causes "rat-bite fever." But organisms can cause more than one type of disease apiece. Many diseases are, as yet, unexplained. It is not impossible that such an organism as this might account for some of them.

If we persevere with the rat for a while, we find that its possible dangers are not exhausted. It suffers from a plague due to a bacillus which causes, in man, food-poisoning and often death. The danger of spread to man is said to be small, but it would certainly seem to be present.

The rat is an unseen enemy, for the most part. At the other end of the scale we may take the domestic cow. A surprising series of diseases are contracted from her. Tubercle in children, especially of the joints and glands, is contracted from the milk. The cow gets diphtheria of the udder, and this frequently gives rise to big epidemics. It can also convey, in its milk—which is an admirable laboratory culture medium—any organism which may chance to get

carried into it. The summer diarrhoea of infants is a milk-spread disease to some extent.

The list may be indefinitely prolonged. The goat spreads Malta fever; the dog gives us a variety of skin diseases and a dangerous parasitic disease known as "hydated cysts." There is scarcely an animal which does not, on occasion, convey disease to man. Even the squirrel, in America at least, disseminates a kind of plague, and the big game of Africa spreads fatal fevers through the ticks that are parasitic on it.

Tetanus Organisms.

During the war the prevalence of gas gangrene in wounds and, in the early days, of tetanus, was a very serious matter. The organisms which cause these conditions were in the highly manured soil; they live, normally, in the intestines of animals. And, to-day, nearly all the cases of tetanus which come to light are caused by scratches or pricks contaminated with manured soil; and the only exceptions are the rare cases in hospitals, where the infection is carried in the cat-gut used by the surgeon. Cat-gut is, of course, an animal product.

Anthrax and glanders, again, are always contracted from animals: the meat-porters of Smithfield often contract the former disease, and every now and again a farm-hand is reported as dying of glanders, which is always fatal.

All these facts are familiar and well-established. But many other possibilities arise. Why do we assume that the whole story is known? Is it not, on the contrary, reasonably certain that animals play a far larger part than is yet known in the spread of diseases whose whole nature is yet undisclosed?

So far we have dealt with bacterial diseases for the most part. We know more of them than of any others. We know next to nothing about the "filter-passing" viruses, thrown into prominence by the work of Gye and Barnard on cancer. But we do know that they are tremendously important. Smallpox and measles, typhus fever and influenza, sleepy-sickness and mumps, are caused, according to present teaching, by "filter-passers"; and, last of all, some types at least, of cancer, if Gye's work proves sound.

So much for man. What of the animal kingdom? Here, again, we find "filter-passers"—to mention only the most prominent, we may cite distemper and foot-and-mouth disease. There has long been a suspicion that distemper and influenza are related. Both diseases are epidemic, and have grave effects on the lungs. There are, of course, many differences: influenza often attacks an individual more than once; distemper only rarely recurs. There seems to be little relationship between the epidemics of distemper in animals and influenza in man in point of time.

Foot-and-mouth disease, again, seems only to have attacked human beings on rare occasions, if at all—at least in the form in which it attacks animals. But in that reservation lies the crux of the situation. "Filter-passers" are not as other viruses; it seems that, at least in some instances, the same virus may set up more than one disease. For example, in man there is a simple and innocuous skin disease known as herpes. The fluid from the vesicles in herpes, injected into a rabbit, causes a condition of the brain which cannot be distinguished from Encephalitis Lethargica, or sleepy-sickness, as it occurs in man.

There have been suggestions that the same is true of other "filter-passers" as well. One virus can set up more than one condition in animal experiments. The work of Gye and Barnard on cancer is of interest in this connection. Readers will remember that their theory is that cancer is a disease in which two factors are involved—a filter-passing virus common to all cancers, and a "tissue-factor" peculiar to each animal and every organ of every animal. Here, again, the fact that the virus itself is non-specific is very noteworthy.

It is plausible to suggest that there may exist diseases in man, transmitted by animals, and that these diseases may present a different clinical picture in the two cases where a filter-passer organism is concerned. If herpes in man gives sleepy-sickness to rabbits, why might not distemper in animals give influenza in man, or some other of the diseases whose spread is at present mysterious?

Infection from Animals.

Infection from animals might explain the strange way in which such conditions as sleepy-sickness and infantile paralysis spread. As a rule, in both cases, there tends to be a severe outbreak in one well-defined district. But the diseases are not infectious in the ordinary sense of the word. It is rare to find more than one case in one household, and there is no danger in nursing patients. Both diseases are believed to be caused by "filter-passers," and the strange features of their outbreaks would be explained it they were contracted from animals who harboured the virus.

These suggestions are pure surmises. The "filter-passer" itself is still at best a plausible assumption; the work of Gye on the cancer virus is the only satisfactory demonstration of its artificial culture and general characteristics, and that work awaits confirmation. The progress of knowledge of the spread of disease has, however, always served to emphasize

the importance of animals in the sequence of events. The so-called filter-passer diseases, alike in man and in animals, await complete interpretation. All that we know of these filter-passers tends to show that they cause, each of them, more than one condition; there may even be only one "filter-passer" capable of causing many diseases in appropriate conditions.

For these reasons the probability is that further research will prove that a still more intimate relationship exists between human epidemics and disease in animals than is yet believed.

Fighting Insect Pests with the Aeroplane.*

A New Method of Protecting Crops.

EXPERIMENTAL work on the use of the aeroplane in agriculture, as a means of exterminating insect pests, has had such success in the United States that a new field of activity of great economic importance is being developed. Half the loss now caused by the cotton "boll weevil"—a blight which damages the American crop to the extent of sixty million pounds annually—can probably be eliminated by aerial methods.

Early Experiments

Under the supervision of the Department of Agriculture, the use of aeroplanes for distributing poison dust was experimented with during the summer of 1922 in certain cotton areas of northern Louisiana and Mississippi. A bad outbreak of the leafworm—another cotton blight—which occurred in several southern states at that time, furnished the medium on which Dr. B. R. Coad conducted intensive work. A technical report was issued by the Government† describing the experiments in detail, and this concluded that financially the use of the aeroplane did not seem to be out of the question, and that there was considerable possibility of pronounced economy as compared with the "dusting" of crops by ground machines.

[*Georgia State College Bulletin.*

THE OLD GROUND MACHINE METHOD OF TREATING CROPS.

The soundness of this opinion has since been confirmed by the commercial work of Huff, Daland & Co., which has established itself on a very promising basis, developed special types of flying equipment, and built up liaison with various agricultural and entomological authorities in the cotton district. One of the most serious problems faced was the procuring of an aeroplane with sufficient power, mobility and safety. A competition resulted in the choice of Wright "Whirlwind J-4" machines, some of which have been in service continuously for months under the most trying conditions, and are reported to be functioning perfectly with a minimum of attention. This aeroplane dusts from 300 to 1,000 acres per hour—more than fifty times as much as the best ground machine can cover. The specially built hopper, containing from 600 to 1,500 pounds of calcium arsenate according to the size of the aeroplane, spreads from 300 to 400 pounds per minute. The distribution is from a height of between ten and twenty-five feet, the air from the propeller forcing the dust down thoroughly over the plants, even on the under side of the leaves, and protecting them more effectively than by the old method.

The company operates as follows: A field is obtained in the centre of a region where work is to be done, and an operation base is established, local interest and co-operation among the farmers having been aroused through the help of Federal and State authorities. It has been found most effective to serve from 5,000 to 7,000 acres within a radius of ten miles from the base, and contracts are not signed for "dusting" less than these areas. The aeroplane operates at a speed of 80 to 90 miles an hour, dust cast from the hopper being caught in the propeller blast and distributed over a path 200 feet wide. At the end of the field the aeroplane makes a quick turn and dusts another lane.

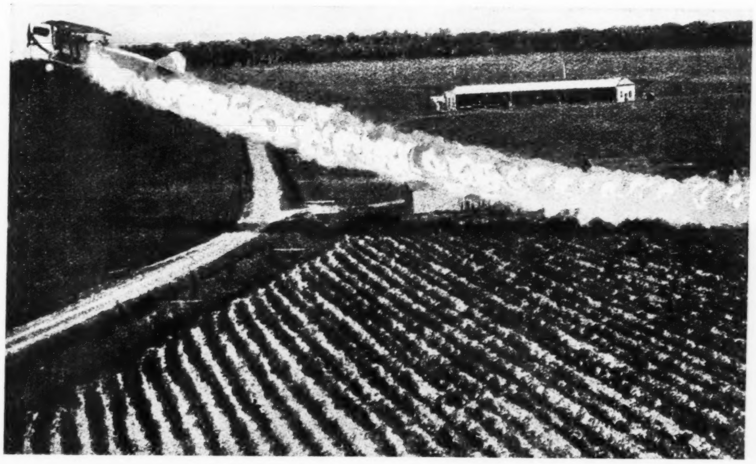
*Reprinted with photographs from "Aerial Anti-Pest Activities," by H. C. Loeffler, *The World's Health*, March, 1926.

† "Dusting Cotton from Aeroplanes." United States Department of Agriculture, Department Bulletin No. 1204.

Two aeroplanes are kept at the base during the season, with a pilot, a mechanic and a boll weevil expert. Photographs are first taken of all the fields to be dusted, these views serving as a record and means of guidance for the farmer.

A Sixty per cent Saving.

In summarizing the benefits of this new process, the Georgia State College of Agriculture* state that dusting by aeroplane will afford a saving of from fifty to sixty per cent in the amount of calcium arsenate required to produce the same results by any other means of delivery at present available. It can be carried on successfully in usual day winds and without the necessity of having the plants wet with dew, thereby eliminating night operation as required in present methods. Dust can be spread immediately after a heavy rain, and operation is not held up by inability to use horses or ground machines in a muddy field. Since immediate dusting after rainstorms is of the utmost importance in order not to lose the benefit of previous applications, the great superiority of the aeroplane method at once becomes evident when compared with the resulting delay of several days before ground equipment can be used.



[U.S. Dept. of Agriculture.

DUSTING AN AMERICAN COTTON FIELD BY AEROPLANE.

The unit area dusted by aeroplanes depends largely upon size and relative location of fields to be treated; but machines have been successfully operated under all possible conditions, and are always more efficient than the best cart machines, even when these are used under favourable conditions. The rapidity of the aeroplane method is valuable in protecting fields where heavy weevil infestation is unexpectedly discovered, since it is possible in a few hours to effect control on areas that would take several days to cover in any other way. This point is of even greater importance in leafworm control where enormous damage will often result from a single day's delay, and must not be overlooked in connexion with dusting for boll weevil control after heavy rains, since in addition to the opportunity for immediate operation it allows the planter to regain control in a few hours' time, where several days would be required with the usual methods.

It is further pointed out that aeroplane control will allow the average farmer to plant and raise approximately 33 per cent more cotton than he has been able to since the advent of the weevil, by taking the dusting problem off his hands and giving him the full use of his labour during the whole season for regular farming work. It allows him, moreover, to reap the direct benefit of the Government Experiment Stations for weevil control, since each aeroplane will protect sufficient acreage to command the services of competent experts to direct the work. In this way the necessity of educating and forcing negro labour to follow the proper methods of dusting is eliminated entirely, and the work is placed in the hands of a small number of skilled operators.

Advantages.

One aeroplane will not only do more work than many cart dusting machines, but costs less in original investment, depreciation and operation. It eliminates the necessity for night operating equipment and the labour difficulties with this phase of the work, removes the need of feeding and quartering large numbers of mules during the whole year when they can only be used to capacity during the few months of boll weevil infestation, and reduces equipment as well as personnel to small, easily controlled units. The aeroplane duster is essentially a mobile machine, capable of travelling from 80 to 100 miles per hour, and reaching emergency operating bases in practically every part of the cotton belt, so that excess equipment, at present provided as a safeguard against unusual conditions on individual plantations, will be eliminated by its use.

Many of these advantages are, however, dependent upon large-scale operation, and calcium arsenate

* "Boll Weevil Control by Aeroplane," by G. B. Post. Georgia State College of Agriculture, Bulletin 301.

treatment cannot be recommended for cotton fields yielding less than a third to a half bale of cotton per acre until application costs are cut down through this means. The cost of dusting by ground methods as calculated by the U.S. Government is \$7.15 (about thirty-five shillings) per acre for five applications, while the aeroplane method works out at \$5.50 for three applications and \$7 for five. The commercial possibilities of the new process are almost unlimited and, with greater co-operative agreements by individual farmers to institute regional dusting operations, costs may be cut still further. The cotton crop alone, it is estimated, could profitably employ more than 2,000 aeroplanes.

Many Other Applications.

The aerial process has also been used for dusting fruit orchards in Georgia, and it will probably be used over the great wheat areas of the north-western states which suffer badly from the green fly. The affected areas cannot readily be seen on the ground, but aerial photographs reveal their location and make control work possible. In Canada research is being conducted on the white pine blister rust, and in Germany successful experiments have been made with aeroplanes to sprinkle arsenic substances on infested forest areas, notably near Eberswalde, to kill worms and other insects attacking the timber.

At the end of last year the Division of Entomology of the Union of South Africa, with the co-operation of the Government Air Service, spread calcium arsenate on about a hundred acres of eucalyptus plantation near Johannesburg in the Transvaal, various species of the eucalyptus having been seriously menaced during recent years by an Australian snout beetle that has spread to South Africa.

This new use of aeroplanes is not confined to agricultural pests, however, for during the past three years experiments have been carried out by the U.S. Bureau of Entomology at Mound, Louisiana, on the distribution of larvicides over the breeding places of malaria-carrying mosquitoes. The process of aerial dusting, in fact, opens up most interesting possibilities, and it is likely that it will prove of use in distributing artificial fertilizers over large areas.

Books Received.

Birth Control and the State: A Plea and a Forecast. By C. P. BLACKER, M.C., M.A., M.R.C.S., L.R.C.P. (Kegan Paul. 2s. 6d.).

Popular Research Narratives. Vol. II. Collected by the Engineering Foundation, New York. (Bailliere, Tindall & Cox. 4s. 6d.).

Clifton College Scientific Society Report. 1924-25.

The Earth and the Stars. By CHARLES G. ABBOT, D.Sc. (Chapman & Hall Ltd. 15s.).

Animals of Land and Sea. By AUSTIN CLARK. (Chapman & Hall Ltd. 15s.).

The Engineer and the Prevention of Malaria. By HENRY HOME, M.Inst.C.E. (Chapman & Hall Ltd. 13s. 6d.).

The Trinity College Record. Feb., 1926. (Trinity College, Washington).

The Brain and the Mind. By PAUL SUNNER. Translated by C. HARRY BROOKS. (George Allen & Unwin Ltd. 3s. 6d.).

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. LV. 1925. July to December. (Royal Anthropological Institute of Great Britain and Ireland. 15s.).

Journal of the British Science Guild. March, 1926. No. 21. (1s.).

A Chapter in the Early Life of Shakespeare: Polesworth in Arden. By ARTHUR GRAY, M.A. (Cambridge University Press. 7s. 6d.).

Living Things. By A. BAILEY-CHURCHILL, B.A. (G. Bell & Sons Ltd. 2s.).

Prehellenic Architecture in the Aegean. By EDWARD BELL, M.A., F.S.A. (G. Bell & Sons Ltd. 8s. 6d.).

Universities Yearbook. 1926. (G. Bell & Sons Ltd. 7s. 6d.).

The Textbook of Topographical Surveying. (H.M. Stationery Office. 15s.).

Vacuum Practice. By L. DUNOYER. (G. Bell & Sons Ltd. 12s. 6d.).

Berwickshire and Roxburghshire. By W. S. CROCKETT. (Cambridge University Press. 3s.).

Life of Plants. By SIR FREDERICK KEEBLE. (Oxford University Press. 5s.).

An Introduction to Practical Biology. By NORMAN WALKER. (Sir Isaac Pitman & Sons. 5s.).

Electricity and Magnetism. By C. L. REYNOLDS, M.A. (G. Bell & Sons Ltd. 5s.).

The National Physical Laboratory Report. 1925. (H.M. Stationery Office. 8s. 6d.).

The Subject Index to Periodicals. 1922. G.: "Fine Arts and Archaeology." (The Library Association. March, 1926. 9s.).

Kompleta Gramatiko Detaloza di la linguo Internaciona Ido DA L. DE BEAUFRONT. (Preco: 2 Suisa Franki).

The Sacred Giraffe. By S. DE MADARIAGA. (Martin Hopkinson & Co. Ltd. 10s. 6d.).

The Holborn Review. Vol. XVII. (Holborn Publishing House. 2s. 6d.).

L'Hellenisme en Lutte contre l'Orient et l'Occident. Par G. S. FRANGOUDIS. (25 francs).

The North-Western Naturalist. Vol. I. March, 1926. No. 1. (T. Buncle & Co. 2s.).

Phototopography. By ARTHUR LOVAT HIGGINS, M.Sc., A.R.C.S., A.M.Inst.C.E. (Cambridge University Press. 6s.).

The Mystery of Mind. By L. T. TROLAND. (Chapman & Hall Ltd. 15s.).

The Soil and Civilization. By MILTON WHITNEY. (Chapman & Hall Ltd. 15s.).

Modern Sunlight. Vol. I. No. 2. April, 1926. (The Sunlight Bureau. 2s.).

Sulla erroneita della teoria relativistica di Einstein. By ING. GAETANO IVALDI. (Estratto dal Giornale "Il Monitore Tecnico.")

Science Progress. No. 80. April, 1926. (John Murray. 7s. 6d.)

La Mento Internaciona. da Cecil Delisle Burns, and *La Bezono di Mento Internaciona. da Professoro R. D. Carmichael.* Dil Universitato di Illinois).

Travel and Travellers of the Middle Ages. Edited by A. P. NEWTON, M.A., D.Litt., B.Sc., F.S.A. (Kegan Paul. 12s 6d.)

The Carnegie United Kingdom Trust Twelfth Annual Report. 1925.

Heredity. By A. FRANKLIN SHULL. (McGraw-Hill Publishing Co. Ltd. 15s.)

Astrophysics : the Riddle of Star Distances.

By A. Vibert Douglas, M.B.E., M.Sc.

The astrophysicist endeavours to measure the size and distances of stars with the aid of the spectroscope, and it is only within recent years that a true idea of the immensities of space is being obtained by this means.

THE young science of astrophysics is the direct and natural outcome of three of the oldest of all the sciences—astronomy, mathemetics and physics. Arising as it does from this triple alliance, it is endowed with the astronomical wisdom of the ages, it wields in its hand the powerful weapon of mathematical reasoning, it adapts to its use the most exquisite instruments of precise measurement that physics can devise and it strides boldly forward into new and ever wider realms of thought and realms of space with all the courage and enthusiasm of youth.

In the days of ancient Greece, Aristotle taught and Ptolemy of Alexandria perpetuated the fallacy that whereas terrestrial things were composed of four "elements"—earth, air, fire, water—the celestial bodies—sun, moon, planets and stars—were composed of a fifth element, a perfect substance, unchanging and unchangeable, the "quintessence." As long as this idea held sway in the minds of men, a science of astrophysics was impossible. For physics deals essentially with *change*—change of position, change of configuration, change of state, change of energy distribution ; change of some kind or there is no physics involved, save only in one limited subdivision of physics, namely, statics ; and even in statics the idea of change cannot be wholly avoided, for many of its problems are solved by recourse to the principle of "virtual work," a principle the basic idea of which is the effect of change.

The Beginnings of Astrophysics.

When Galileo turned his hand-made telescope upon the Sun and found upon its surface strange, dark markings which altered both in shape and position from day to day, he threw down and trampled under foot forever the dogma of the immutable fifth substance. There were changes on the face of the Sun, great convulsions which darkened portions of its dazzling surface ; there were small satellites which moved round and round Jupiter ; there were stars which blazed forth a temporary brilliance—all testified to a great law of change ruling in the heavens as well as upon the earth ; and from the moment this was realized a science of astrophysics became *theoretically* possible.

When Isaac Newton passed a beam of sunlight through a glass prism and obtained thus a separation of its rays, the beautiful orderly array of spectrum colours, he achieved the first step towards making a science of astrophysics *practically* possible. For since there is no means of gaining information about the stars save that which can be read in the beam of starlight itself, the first essential to the problem of disentangling the riddle of the stars is to be able to analyse starlight.

In the judgment of F. J. M. Stratton, the science of astrophysics may be said to have had its actual beginning when in 1802 Wollaston observed that the spectrum of sunlight did not consist merely of a coloured band of light, but also of certain sharp narrow dark lines crossing the spectrum at right angles to the direction in which the colour changed from red to violet. He noted seven such lines.

In 1814 Fraunhofer made a more detailed study of the solar spectrum and mapped 574 of these dark lines. He compared also the lines in the spectrum of direct sunlight and of sunlight reflected from Venus. For his pioneer work in spectroscopy his memory is honoured by his native city in an imposing statue on the great Maximilian Strasse in Munich, while the scientific world honours him by referring to the solar lines as "Fraunhofer lines."

Forty-five years elapsed before an explanation of these dark lines in the solar spectrum was forthcoming and then it was Kirchoff whose insight enabled him to associate each dark line with a definite type of atom in the outer atmosphere of the Sun. He realized that cool gases will absorb just those radiations which they can themselves emit if raised to sufficiently high temperatures and hence they rob the out-streaming solar radiation of certain definite frequencies. Thus the resulting absorption lines give an indication of the elements composing the solar atmosphere.

Star Spectra.

The pioneer in the application of spectroscopy to starlight and the first to design a spectroscope by which he saw and studied the individual stellar spectra, and hence in a very real sense deserving of the title of Father of Astrophysics, was Sir William Huggins.

The step from the visual study of star spectra to the obtaining of a photographic record of their spectra was taken in 1872 by Henry Draper. Shortly after-

wards, at the Harvard College Observatory, a line of research was initiated which has progressed unceasingly, and has led to several critical attempts to classify the stars according to their spectra, culminating recently in the completion of the Henry Draper Catalogue of over 200,000 stars, the spectra of which are classified by Miss A. J. Cannon, veteran astrophysicist of Harvard College Observatory.

Hartmann of Potsdam achieved the accurate measurement of the wave-lengths of the absorption lines in a spectrogram by means of a comparison spectrum whose lines are known and which is photographed on the same plate as the starlight, both above and below it. Thus it became possible by the precise measurement of line positions to deduce their shift towards the red or towards the violet, if such shift existed, and in this way by the application of Doppler's principle* to calculate the velocity in the line of sight.

With the beginning of the twentieth century there came an almost startling advance in the realm of pure physics. The work of J. J. Thomson and others on the nature of the electron, and the investigations of Rutherford and his associates into radioactivity and the nuclear structure of the atom, led to the theoretical work of Bohr upon the hydrogen atom, and this gave for the first time a reasonable explanation of the empirical facts of spectroscopy. The elaboration of his theory by Bohr and also by Sommerfeld has greatly amplified and strengthened this physical basis for the interpretation of spectra,[1] and astrophysicists were not slow to recognize that herein lay the path to the understanding of the physical conditions prevailing in stellar atmospheres.

Luminosity and Distance.

One of the great problems of the astronomer is to determine the absolute magnitude of a star. Apparent magnitudes were placed upon a logical, though of necessity a quite arbitrary, basis by Sir John Herschel about 1859, but apparent magnitude is a function of the star's distance from the solar system as well as of the actual physical properties of the star, whereas absolute magnitude on any arbitrary scale is a function only of the physical condition of the star. By almost universal agreement the absolute magnitude of a star is taken as equal to the apparent magnitude which it would have if viewed from a distance of 10 parsecs —a parsec being the distance corresponding to a parallax of one second of arc, that is to say, the angle at the star subtended by the Sun-earth distance is one second if the distance to the star be one parsec.

If apparent magnitude be denoted by m, absolute magnitude by M, and parallax by p, a very simple relation can readily be shown to exist, as follows:—

$$M = m + 5 + 5 \log. p.$$

It is thus evident that, given m and p, it is possible to calculate M, and this has been the road of approach of the astronomer. He measured by trigonometric survey of the sky the distance of the star, or in a few particular cases deduced its distance from its proper motion, and then he calculated its absolute magnitude. The approach to this problem by the astrophysicist has been from the opposite direction. He attempts to interpret the star spectrogram in such a way as to deduce its absolute magnitude and then from this and its known apparent magnitude he calculates the parallax. Values of luminosity and distance thus obtained are called "spectroscopic absolute magnitude" and "spectroscopic parallax."

The Key to the Problem.

The first step toward the spectroscopic determination of absolute magnitudes was taken independently about the year 1914 by Hertzsprung and Kohlschütter. They found that two spectra might be so similar in general appearance as to fall naturally into the same class and yet in a few particular details exhibit such marked difference that each could be readily identified. Thus the two stars α Tauri and 61′ Cygni are both placed in spectral classification[2] K (α Tauri K5, 61′ Cygni K7) and yet close examination shows important differences in certain lines in the two spectra: for example, the calcium line (λ4455) is weak in the former and strong in the latter, whereas the strontium line (λ4215)[3] is strong in the first case and weak in the second. These facts of observation acquire a significance as soon as two things are realized: (1) α Tauri is a very luminous giant star of absolute magnitude 0.4 whereas 61′ Cygni is physically faint[4] a dwarf star of absolute magnitude 8.0; (2) the calcium line (λ4455) is associated with an energy change occurring in a normal calcium atom, whereas the strontium line (λ4215) can only be produced when strontium atoms are under such physical conditions that ionization of the atoms has taken place, or in other words, that the outermost electron of each atomic system has been removed, leaving each strontium atom no longer neutral but with an excess unit positive charge. Thus, since it is known that high ionization implies a low gas pressure in that portion of the stellar atmosphere in which the "enhanced" line originates, it follows from the above-mentioned facts that high stellar luminosity is to be associated with low pressures, and a consequent increase in ionization, whereas low luminosity is implied when the spectrum shows a relatively weak ionization and a strengthening of the lines of the neutral atoms.

* See "Measuring the Universe," *Discovery*, vol. v, p. 196.
1 See concluding footnotes, page 177.

These were the ideas developed by the first and chief worker in the field of spectroscopic parallaxes, W. S. Adams, who by 1916 had found more than a dozen lines sensitive to changes in physical conditions in the stellar atmospheres and therefore suitable as the basis of a systematic search for a quantitative relation between the relative intensities of selected lines and absolute magnitude. Making use at first of 125 known trigonometrical parallaxes he found that satisfactory relations did exist between these factors, and in 1917 he published a preliminary list of absolute magnitudes and parallaxes thus determined. By 1920 Adams and three of his associates at Mt. Wilson had determined these factors for 1,646 stars.

Theoretical Considerations.

Since that time several others have been drawn into this work either as contributors to the theoretical basis or as partakers in the actual task of interpreting spectra with this end in view. Of the former, Pannekoek, Stewart and Eddington are the chief. Pannekoek has pointed out that the difference in the relative intensity of selected spark and arc lines (due respectively to an ionized and a neutral atom) in two stars indicates the difference in luminosity only indirectly—it is in reality a measure of the difference in the value of surface gravity on the two stars, and surface gravity is proportional to the ratio of mass to luminosity :

$$g=s\ M/L$$

—where g=gravity, M=mass, L=luminosity, and s=surface brightness, a constant for a given spectral class. Hence if a star's mass differed greatly from the average mass of stars of its class, the spectroscopic absolute magnitude would be very much in error.

The important result obtained by Eddington connecting mass and luminosity in the form

$$L=f(M)+\text{Const.}$$

has a direct bearing in this connection for it shows that luminosity may be interpreted as a function of gravity only, within a spectral class. Thus Pannekoek's main ground of criticism of the accuracy of spectroscopic parallaxes is rendered less serious.

Stewart has discussed the effects of different pressures upon radiating and absorbing atoms and has drawn attention to an important point in connection with the width of lines in the stellar spectra, namely that in giant stars, in contrast to dwarf stars, the pressure is low and the intensity of an absorption line will be greater on account of the greater depth of atmosphere ; also the line will be narrower and sharper because even at this greater depth the pressure is less, there being both a lower surface gravity and a smaller pressure gradient than for a dwarf.

Solving the Riddle.

Following upon the work at Mount Wilson several other observatories equipped for taking slit spectrograms have undertaken the examination of their plates with the same purpose in view. At the Dominion Astrophysical Observatory, Victoria, B.C., this has been accomplished with marked success by Young and Harper. They based their determinations on ratios of fourteen pairs of spectral lines, some of which had already been shown suitable by Adams, others of which they found for themselves and demonstrated to be reliable. Their list of 1,105 spectroscopic parallaxes showed such a good agreement with the Mt. Wilson values that confidence in the method has been considerably strengthened.

At the Observatory of Upsala, careful determinations have been made by Lindblad and at the Norman Lockyer Observatory, Devon, two valuable contributions have been made by Edwards and Rimmer. Each worker evolves his own individual method applicable to the class of spectra he is examining, but the fact that diverse minds following diverse methods produce results which are confirmatory and harmonious is sufficient to encourage others to continue the quest and to inspire them with an assurance that the quest will not prove fruitless.

Thus is starlight being made to tell its own secrets, to reveal even the secret of the vast distances of space which separate one star from another.[5] One may well ask, What are the limits to this method or has it unlimited possibilities ? The answer lies in the fact that even with the finest telescope and spectrograph it is impossible to get good spectrograms of stars fainter than a certain magnitude, and of course where no spectrogram can be obtained this method is inapplicable.

But long before this and other methods of solving the riddle of star distances have been exploited to the full, we may feel confident that the mind of man, by theoretical and by experimental advances, will have opened up new avenues of approach to a fuller knowledge of the stars—what they are, where they are, from whence they come and whither they go.

(1) In Bohr's theory of the atom an electron revolving about the atomic nucleus may move in many distinct orbits, but the atom possesses greater energy the larger the orbit in which the electron revolves. When the electron changes its orbit, energy is either absorbed or emitted by the atom according as the new orbit is farther from or nearer the nucleus. Each possible transition involves a definite change in energy, and a definite amount of energy corresponds to a definite wave-length of radiation. Hence a line of known wave-length in a spectrum may be associated with a certain orbit transition on the part of the electrons in the atoms responsible for that radiation. These relations are now known for a large number of spectral lines.

(2) Spectral classification is done on what corresponds to a temperature scale—the hottest known stars are class O, then classes B, A, F, G, K, M, in descending order of the surface temperatures of the stars. Sirius belongs to A, our sun to G, Arcturus to K, Antares to M, and so on, the range of surface temperatures being approximately from 25,000° C. to 3,000° C.

(3) λ 4215 is the spectroscopist's method of designating a spectral line due to radiation of wave-length 0.00004215 cm.

(4) On the scale of star magnitudes negative values indicate the most luminous stars, while larger and larger positive values indicate less and less bright stars. Thus Sirius of apparent magnitude -1.6, looks brighter than Aldebaran, $+1.4$, which in turn looks brighter than 61′ Cygni $+5.6$, but if all were viewed from a distance of ten parsecs, then Aldebaran would appear the brightest, absolute magnitude $+0.4$; Sirius would be much dimmer, $+1.3$, and 61′ Cygni would be too faint to see with the naked eye, $+8.0$.

(5) The distances thus determined range from those of our nearest neighbours in space to those stars so remote that their light travels through space for over a thousand years before reaching our solar system. When it is recalled that light travels 186,000 miles every second, the immense distances of even these less remote stars can be appreciated. The vast distance between stars can perhaps be realized if one takes as a typical case the distance from the sun to the nearest star, α Centauri—suppose the sun to be represented by a ball one inch in diameter, then the nearest star would be another ball, very much larger perhaps, but placed 100 miles away.

BIBLIOGRAPHY.

Herbert Dingle—" Modern Astrophysics," 1924.
F. J. M. Stratton—" Astronomical Physics," Cambridge University Press, 1925.
J. Bosler—" Evolution des Etoiles," 1923.
W. S. Adams—" Spectroscopic Parallaxes," *Astrophys. Journal*, 83, 1921.
Rimmer, *Memoirs R.A.S.*, 1923.
Edwards, *M.N.R.A.S.* 83, 47, 1923.
Young and Harper, *Journal R.A.S.C.*, January 1924.

A New Drawing Device.

AN example of the practical improvement of a working device by the application of a simple scientific principle is afforded by the magnetic tee-square now marketed by Axene, Ltd. The new tee-square is identical with the ordinary type, except that in place of an ebony edge to the head it is provided with a stainless steel magnetic working edge. This automatically adheres to a steel strip that is provided with the square, and is easily attached to any drawing board. The invention should appeal to every draughtsman, as it gives him a " third hand " for his work, and while the new square can readily be moved in the same way as the old pattern, it can be left in any position and will remain fixed there indefinitely until work is resumed. The " Axene " tee-square has no clamps, springs, or other " gadgets," and appears to be in every way a thoroughly practical instrument.

Correspondence.

THE INVENTOR OF THE OPHTHALMOSCOPE.

To the Editor of DISCOVERY.

SIR,

In his recent article on " Helmholtz's Physiological Optics," your reviewer rightly draws attention to the precedence of an Englishman, Robert Smith, in the discovery of the tangent law. He does not refer to the little-known fact that it was an Englishman, Charles Babbage, the famous mathematician and inventor of the calculating machine, who discovered the ophthalmoscope in 1847, *i.e.*, four years before Helmholtz rediscovered it. In the third edition of Wharton Jones's " Manual of the Principles and Practice of Ophthalmic Medicine and Surgery " (John Churchill, 1865), the author says: " Here I ought not to omit stating that in the spring of the year 1847, Mr. Babbage showed me the model of an instrument which he had contrived for looking into the interior of the eye. The reflector was a small plain glass mirror, with a part of the silvering rubbed off to look through." Unfortunately Wharton Jones did not realize the importance of the discovery, as did von Graefe; with the result that Helmholtz got the credit, and German ophthalmologists had a good start in describing hitherto unseen pathological conditions at the back of the living eye.

Yours faithfully,

J. HERBERT PARSONS.

54 Queen Anne Street, W.

" BOROCAINE."

To the Editor of DISCOVERY.

SIR,

Being the proprietors of Borocaine we have read your recent article on the subject with exceptional interest, but we should like to correct an error which occurs in the second column. It is stated there that Messrs. Copeland and Notton discovered cocaine borate, which is described in the article as borocaine. As a matter of fact, although Copeland and Notton did work with cocaine borate, they found that two other borates—ethocaine borate and beta-eucaine borate—were infinitely superior to all the rest. They had the further merit of being non-toxic, cocaine borate, of course, being extremely toxic. The non-toxic borates are now known as " the two borocaines," ethocaine borate being named Borocaine, and beta-eucaine borate—Beta-borocaine. These names have been registered by us as trade marks.

The following extract from the original paper by Messrs. Copeland and Notton (vide *British Medical Journal*, 26th September, 1925) is of interest :—" As the result of an extended series of experiments, Copeland and Notton find, in confirmity with the theoretical considerations set forth, that the borate is the best salt of any anaesthetic alkaloid, and that ethocaine is the most suitable base to combine with boric acid for general use. The resulting salt, known as borocaine, is the most generally suitable local anaesthetic available."

Yours faithfully,

THE BRITISH DRUG HOUSES LTD.

16-30 Graham Street, N.1.

The Bee as an Individual.

By C. Burghes.

Although "the busy bee" has become proverbial, she is not generally imagined as a creature of individual tastes and habits. Why bees work is only one of the fascinating problems that the entomologist is seeking to answer.

THE study of the habits and behaviour of insects has always appealed to the human mind. Even those people who cannot pronounce the word "science" without a shudder, and who consider the scientist one of the most dangerous of men, have little to say against the entomologist. The investigation of the ways of ants, bees, moths, and even spiders, is considered a harmless and even laudable pursuit, and those who undertake it are regarded as amongst the most amiable of men.

Insect Psychology.

I fear, therefore, that I shall arouse antagonism by my suggestion that, on the contrary, the modern entomologist may be regarded as far more dangerous to the peace of society than the inventor of a new poison gas. For, although the new weapons of warfare may be destined to destroy thousands of human beings, the new methods and views now entering into entomological research will ultimately have a stranger effect on human destiny. Such men as Wheeler of America and von Frisch of Germany have not only a tale of wonders to tell, but a moral to draw or to suggest, which must in due course influence philosophers, sociologists, and the people. They are giving us grounds, very practical grounds, on which we may talk of insect psychology, and when we study their works we cannot help noticing the remarkably close similarity between this psychology and our own. We shall also notice great differences, but the mere fact that one can now seriously compare the mind of a human being to the mind of a bee is a direct challenge to compare the relative organizations built up by those minds, not necessarily to the entire advantage of the former.

When a priest or a politician endeavours, some time in the future, to convince a critical audience that the existing order among men is the best possible, he may be challenged by a heckler with the question: "Wot abaht the 'ive?" and if he has any acquaintance with the facts I am about to bring forward, his complacency may be somewhat shaken.

I described in a previous paper* what Herr Professor Karl von Frisch has been able to tell us about the sense perceptions and methods of communication of the bees. He elucidated chiefly the following points:—

1. The bee sees colours more or less from the same point of view as a colour-blind man, *i.e.*, red and green do not convey much to it. For blue and yellow and all colours which have an admixture of them it has keen perception. But it is believed to be able to see colours in the ultra-violet which for us have no meaning.

2. The sense of smell of the bee is intensely developed, possibly better than our own. It possesses a special organ which it can use to convey information through this sense to its companions.

3. It "converses" with them by means of mutual feeler-rubbing and "ritual" dances in which the sense of smell also plays a prominent part.

But, in addition to discovering these facts, von Frisch invented a technique which may be of even greater importance than its first results. He constructed an experimental hive with glass sides through which a colony of bees could be observed and controlled. More essential still, he found a means of identifying individual bees by marking them with spots of indelible colour arranged according to a code.

This technique has led to astounding results, and more will follow. It has enabled Rösch, a pupil of von Frisch's, to observe the life of individual bees from their emergence from the pupa cell until their deaths. He has now got a community in which every single bee is marked and traceable.

Nearly everyone knows roughly what a comb covered with crawling bees looks like. It is just about as easy to trace an unmarked individual in such a swarm as it would be to pick out one man from a crowd of demonstrating people in a public square from an aeroplane.

The Mother Hive.

Some people may find it difficult to think of a bee as an individual, and in order to make it easier I am going to substitute for the identification number used in his experiments by Rösch a name borrowed from Mr. Rudyard Kipling. For Kipling, who one presumes has little use for human Communists, has written the finest account of bee communism in English fiction, a short story entitled "The Mother Hive." His "heroine" was called Melissa—a charming and appropriate name which I propose to adopt here.

* "The Language of the Bees," *Discovery*, vol. vi, pp. 79 *et seq.*

The Life-Story of Melissa.

Melissa is destined to be a sterile female, exactly like every other hive bee except the queen and the drones, who have specialized in the sexual duties towards the community. It is not to be supposed that we need feel sorry for her on that account. She may be keen on her career or she may not—there are more kinds of bee than the eternally busy one—but she will have plenty of variety in her life. She will certainly not be as bored as a queen, doomed to go from cell to cell on her eternal egg-laying round. She will have many jobs to perform, which may sometimes overlap, and she will have at least one exquisite thrill which ought to make every worker's life worth living.

As soon as she has left the cell in which she has become a complete bee she will have a good wash. She will take plenty of time cleansing her whole body with her legs. She begins with her head and eyes, in order to rid them of the pupa skin which may still be sticking to them, then she will rub her feelers and wings and make some experimental fluttering movements with the latter. She may get hungry during the process, and if so she will "beg" food from older bees who will supply it. And so to work. Melissa now begins to visit empty brood cells in the "nurseries"; slipping in and out of some for a few minutes, ignoring some, and remaining in others for several minutes. If such cells are marked and watched after they have been visited by one or more young bees one can invariably see, sometimes within an hour, that they have been visited by the queen who has deposited an egg in each.

The peculiar behaviour of the egg-laying queen, as well as of the cleaners, with regard to the empty brood cells, shows clearly that those which have been cleaned are distinguished by them from the others. During her walk through the nest the queen often comes to empty cells from which the young have crept, but which have not yet been cleaned. She puts her head in, appears to notice that they have not been prepared, and goes on. Soon a young cleaner arrives, who also sticks her head into the cell, and immediately creeps into it; others may do the same. If, after this, the queen returns that way, she pops her head in again, is satisfied that the cell is ready, and deposits an egg in it. It is not yet certain how the queen or the cleaner can distinguish between a cleaned and a "dirty" cell. Owing to the darkness of the hive optical impressions cannot guide them; probably the sense of smell does so.

Melissa can find no more cells to clean, or else she wants a rest. So she finds a comfortable place on the nursery comb and sits down—perhaps for hours. But this does not mean that she is just lazing about. Experiments in lowering the temperature of the hive have shown that if it falls below a certain point, crowds of bees that had been crawling about apparently aimlessly now cluster in a dense circle over the nurseries in order to keep them warm. Melissa is not at this stage ready to perform any other job, but even her inactivity is useful.

From her third day onwards her behaviour alters. She now constantly visits the honey and pollen stores. She finds a full cell, remains there awhile sucking, and then returns to the nurseries, beginning a similar search to her quest for a cell to be cleaned. But her objective is now a different one. She is now looking for a cell containing a larva. She pours some of the honey-pollen mixture she has imbibed over it; she has become a nurse. Again she does not work like a slave but like a citizen. Sometimes she will feed for a little while and then, as if she considered her duty done for the time being, she will sit about cleaning herself or just doing nothing. Then she will suddenly begin work again.

Melissa does not feed larvae indiscriminately; she will hunt around for a long time as if looking for a particular kind of cell. She is, in fact, looking for such as contain larvae in the final stages of development.

Now it is known that the food of the bee-larvae does not consist merely of honey and pollen—it has three ingredients: these two and a special component called "jelly." Up to the fourth day of their lives the larvae receive this jelly from the older nurses, bees aged six to thirteen days. Afterwards they are additionally fed by young nurses such as Melissa, who supplement their diet with the honey and pollen fetched from the store. This raises a peculiarly fascinating point, but it appears almost certain that the nurses of both groups are able to tell the difference in the ages of their charges. How they do so is not yet known.

Exploring the Hive.

After a short spell of such duty, curious things begin to happen to Melissa. She begins exploring the hive; presumably she finds it exhausting, for she will sit down at any place any time for a rest. Whereas previously she would run away as if frightened when an excited old bee coming in with the honey pushed her way into the middle of the comb and began her "information" dance, Melissa now finds herself quite interested in the strange event. She even ventures once or twice to take honey from the old girl. Exploring ever farther she arrives near the door-hole. There is a constant crowding in here,

a continual rushing out. Suddenly Melissa is caught up with an outgoing gang; infected by some strange new enthusiasm, she is off with them—in a moment she has left the warm familiar darkness behind her, and is on the wing!

Melissa flies! I will venture beyond the strict accuracy of ascertainable fact and dare the surmise that she is happy, and that only in recent times has it been made possible for human beings to know just how happy she may be. We, too, spend most of our time in youth in dark, warm places; we, too, may one day rush to a jumping-off place; and we, too, can wing our way into the air, into the blue sky and the golden sunshine. Throwing all caution to the winds, I suggest it must be even more wonderful for Melissa than for us. And those who are so fond of asserting the superiority of the human over the insect race need not retort with reminders about honey-gathering and duty. Nothing of the kind. Melissa is flying for fun and for fun only.

Flying for Fun.

It is worth insisting on this point. "It must be made clear," says Rösch, "that the purpose of these early flights is not the getting of food, as has always been superficially stated in the literature. I have often offered drops of sugar water to bees who were beginning their first flight; they either sipped it casually or in most cases flew away from it. It is on the contrary often to be observed that on their return to the hive these creatures are fed by their fellows. In fact, this flight is to be considered purely directional. The young bee, immediately after leaving the hive, turns her head towards it and, keeping in that direction, she flies in small circles around the place whence she departed. She is learning to understand her environment; she is storing memory pictures, which will afterwards guide her. That the young bee does learn on her first flight I have proved by taking away from the combs marked bees which had just returned, and letting them loose at a short distance from the hive. They all found their way home, whereas a bee which had never yet been out was unable to do so on being liberated."

After this delirious excursion, which may be repeated again on a warm, sunny day, Melissa goes back to sober indoor duty. If the community is in a state of growth and has more young to look after than usual, she will continue her nursing for a while. But the first contact with the outside world has given her what for us would be expressed as "new ideas"; at any rate, she can now take over duties for which excursions and the ability to recognize her home on returning are indispensable.

At this time, which Rösch calls the second period in the hive, in order to emphasize the fact that Melissa does *not* become a field-worker immediately after her first flight, she does various jobs all more or less connected, such as taking the food from laden field-sisters, storing it, packing down pollen, removing rubbish and corpses, helping the young to break their cell-lids, and finally, sentry-duty. If she were given to human sentiments and human ways of expressing them, Melissa could hardly "grouse" on the grounds of monotony.

One or two points in connection with these pursuits may be referred to briefly, though sentry-duty merits more attention. In order to find out just how the honey was distributed, Rösch made an ingenious experiment. He fed the field-bees of an observed community with red-coloured sugar water at a definitely chosen spot, and after they had carried back the first drops of it he found the same red colour in several honey cells. It was also seen that several intermediary bees, who had taken it from the "gleaners" to the store showed a similar red colouring of the skin between the abdominal segments.

Another experiment: The bees who bring in pollen do not give any of it to their companions. They take it straight to the appropriate comb, look around until they find a suitable cell, enter it, and stroke the two little "drawers" of pollen as they are called, off their legs. After taking a little honey they immediately leave the hive again. But there is still work to be done there. The two lumps of pollen that lie in the cell must be smoothed down. On 23rd September, 1924, Rösch observed Melissa, or No. 101, doing this. After she had left the cell, he artfully removed the glass, took the smooth pollen out, divided it in two, and laid the bits back in the same cell. Soon Sacharissa (No. 102), who had been sitting near by, went into the cell in her turn, and pressed the divided lumps down tidily again.

A Regular Sentry System.

When Melissa goes on sentry-duty we find the first real test of her enthusiasm for the hive. His remarks on this subject are among the most valuable made by Rösch. As his account of his observations cannot be bettered I will simply translate it here:—

"It has already been ascertained that honey bees have a regular sentry-system. I noticed that various workers always remained in or near the door-hole. In the morning, when the first fliers start out, they are already there, and in the evening or in cool weather, they are always near by. They behave in an interesting way. With their feelers and half-opened wings they control every incoming bee, run excitedly

to each one as soon as she comes to rest on the board, and do not permit her to enter until they have explored her thoroughly with their antennae. They seek to attain even those hovering slightly above them with a 'snapping' movement towards them, standing on their back legs and waving their front legs and feelers after them.

"If an unwelcome guest or a robber arrives on the board, a whole crowd of sentries immediately throw themselves on him, hold him tight with their mandibles, pull him about, and try to sting him. The battle does not always go in favour of the defenders, but such fights take place constantly. The sentries also react immediately in the case of small stones, dead bees, or foreign bodies thrown on the board, all of which are carefully examined.

"It was always thought that there was a special caste in the hive charged with sentry-duty. But, as is shown by watching marked bees carefully, this is not so. They do not remain long at the door-hole. This is the last task undertaken by each worker and according to age, before going on field-duty. *It is discharged with varying enthusiasm.* I observed some bees which remained on sentry-go for one to three days, taking only short periods for feeding and directional excursions, immediately dashing to the spot when there was sign of a fight with so much enthusiasm that they nearly rammed one another; while many others were much less keen fighters, remaining farther inside the hive and often going back to 'store-work.' Bees at the preceding and following age-stages do not take part in defence or fighting and go their ways quietly even though a battle may be raging on the board."

Gathering Honey.

And now Melissa enters on the last stage of her career, the gathering of honey or pollen. What makes her go out for the first time to the flowers? How does she decide to specialize in getting either honey or pollen? (for no bee ever collects both). We don't yet know. But undoubtedly when she first goes out Melissa, having initiative, does not follow more experienced hunters. She seems to prefer free-lancing, and endeavours to discover a new source of food. Not only does this make her a valuable asset to the hive, but as new young bees are constantly streaming from the home, it will make it pretty certain that no newly-opened flowers in the vicinity will be overlooked.

We are approaching the end, for Melissa's whole life, with all its responsibilities, thrills, adventures, and dangers, will only last in the summer from four to six weeks. Veterans of eight weeks have been known, but are rare. If she has the luck to be born at the right moment, she may hibernate with the queen and live as many months—but it will be a dim sort of life compared to that of the summer bee.

Our friend the moralist, who could never miss an opportunity such as this, has been at hand to suggest that Melissa actually "works herself to death." "Certainly," concludes Rösch, "an observer peering into the crawling, wriggling crowd in the hive might think that feverish activity reigned there. It is by no means certain, however, that this is the case, and it can definitely be said that the industry of the bee varies according to the individual. There are many bees that are definitely lazy, whom one may see sitting or running about aimlessly for hours."

Some Conclusions.

So we may leave Melissa to an honourable end, since we have chosen a model bee as our subject, without being convinced that all of her sisters will have equally deserved it, any more than all of us do. But the non-scientific student may perhaps point out that there is no evidence that Melissa believes in immortality, or that she may not have a "religion" which tells her to do her duty in this world without counting on the next to make up for lost time. According to Dr. Broad, Professor Taylor asserts that "if we and all the human race will eventually die, certain acts which it would be our duty to do on the opposite alternative will not be duties. And certain other acts which it would be wrong to do if we were immortal, would be harmless and reasonable enough if the lives of ourselves and our fellows are limited to the three-score years and ten which we spend in this mortal body. The reasonable course of life on the latter alternative would be that which is sketched for us in Horace's Odes. Since this mode of life would not be wrong if we were mortal, we can conclude that we are not mortal."

The evidence does not incline us to think that Melissa leads a Horatian life of pleasure. Her usefulness to her community is greater than that of many human beings to theirs, and on these grounds it may be urged that Melissa has a much greater claim to immortality than they have. She has no religion in St. Theresa's sense, but some people, myself among them, may prefer the organization of the hive to that of the convent.

There are other alternatives, no doubt. But I claim that the fact that we are compelled to regard them from an angle of vision which must include the hive is proof of my earlier statement that humanity has perhaps much to hope for and much to fear from the investigations of the entomologist.

The Month's Wireless Developments.

THE ELECTRICAL EQUIPMENT AT RUGBY.

By F. H. Masters.

(Editor of "The Electrician.")

In last month's issue of *Discovery* I gave an account of the "two-way" radio-telephonic conversations which are being conducted between this country and America, using the new station at Rugby as the transmitter. The primary object of this station was, however, to provide England with a wireless telegraph installation of world-wide range, and its erection was in fact begun on the advice of the Wireless Telegraph Commission which was appointed in 1921, under the chairmanship of the late Lord Milner. Something may therefore be said about the equipment that has been installed for this purpose. As my space is limited it may be mentioned that full details of the constructional portion were given in a paper read recently by Col. A. S. Angwin and Mr. T. Walmsley before the Institution of Civil Engineers, and in a paper read before the Institution of Electrical Engineers last month Mr. E. H. Shaugnessy gave a great deal of information about the "wireless" portion of the transmitting equipment. Both these papers will be published in full in the Proceedings of the respective Institutions. The power plant has also been fully described in the technical press, and this article will therefore be mainly concerned with the high-frequency generating valve plant.

This plant is designed to utilize thermionic valves, and to be capable of dealing with an output to the aerial of 500 kW. continuously under commercial traffic conditions. The wave-length is 18,000 metres, and the aerial is divided so that two transmissions can be effected simultaneously. At present one of these aerial systems is being used for the telephonic experiments mentioned above. The energy is drawn from a tuning fork which is maintained in vibration by a valve. This vibration is remarkably constant. The output from this tuning fork is amplified once at low frequency. A special part of it is then separated from the rest and amplified three times with low-frequency valves, giving a final output of 100 W. This "tuning fork unit," as it is called, is carefully screened by being contained in copper boxes.

The output from the tuning fork unit is amplified three times before it is delivered to the aerial circuit, the various stages being designed to deal with inputs of about 4 kW., 50 kW. and 1,000 kW., the final output to the aerial being 540 kW. Tests show that the efficiency of the station on three-quarters power is about 64 per cent. The first two stages are combined to form what is called an "exciter unit," while the final stage is known as the "power unit." The arrangement of the apparatus, which is not without its complications, is most ingenious, and is planned so as to obtain the highest degree of convenience in operation. The control is relatively simple, and the various units may be changed over, switched-in, or made dead from one central position.

Safety-First Apparatus.

The devices employed to prevent accidents to the personnel and to the relatively sensitive apparatus should also receive mention. The power is supplied by motor-generators driven from the mains, and as the final electrical pressure on these is 15,000 volts they are enclosed in expanded metal cages, the doors of which cannot be opened unless the system is dead. If they are forced open the machines are at once switched off and put to earth. If a fault occurs on one generator not only it, but the others working with it, are cut out. This is effected by oil circuit-breakers, which are a novelty on high-tension direct-current circuits. Similarly the power unit, which consists of 18 valves, is enclosed and the switch connecting it to the bus bars cannot be closed until this enclosure has been locked and the keys incorporated in the switch itself. The gates cannot be re-opened until the key has been freed by opening the switch, and sliding back the gates earths all parts of the power unit.

To protect the valves against incorrect operation all the safety devices and relays are interlinked in one circuit through the holding coil of the high-tension d.c. switch. A disconnection in any place will prevent the switch from being closed, while the breaking of the circuit at any point during transmission due to fault or overload will also open this switch. This equally applies if the water system used for cooling the valves fails for any reason.

It may be mentioned that the station is actually operated from the Central Telegraph Office inLondon, but the engineer on duty can check the signals and also control the whole of the plant from his table. The station has now been at work for several months, and has not only given good results but has caused extraordinarily little interference with other stations broadcasting and otherwise.

The Post Office engineers are to be congratulated on the skill and ingenuity that is displayed in the

design of this station, for they indicate clearly that we are well in the van of radio development.

THE TECHNIQUE OF BROADCASTING.

By Edward Liveing, M.A.

(Manchester Station Director, British Broadcasting Company.)

In my notes last month I promised to say something about the technique of the broadcast talk and the broadcast short story. Perfection cannot be wrought in a new art in the first few years after its inception. Many years are needed in which to crystallize the results of the broadcaster's work, and it always has to be remembered that the history of broadcasting goes back for only three and a half years. The broadcast organization in this country does not pretend to have brought the art of the wireless talk to perfection as yet. It may, however, justly claim that the talks which it has given to the British public have been on a more purposeful and comprehensive scale than those of foreign countries, and moreover, many of the finest brains in the country have been enlisted to enlighten the public on those subjects of research in which they are interested. Here again British broadcasting has given the lead to many other nations.

Listeners' Criticisms.

There has been a good deal of rather foolish criticism in certain quarters about the quantity of talks appearing in wireless programmes. At the back of this criticism there are, I think, three factors.

(1) Talks do not necessarily have such a universal appeal as music (though in the direction where they do appeal, they make an intense appeal). To illustrate my meaning, there is very little doubt that a performance of the "Tannhaüser" Overture would have a more general appeal than a talk by some well-known authority on "The Lost Races of America," though the latter would make a strong appeal to certain types and sections of listeners.

(2) Most talkers are men who have been in the habit of lecturing in lecture halls, or of writing articles.

(3) The average listener is not yet playing his part in broadcasting, and is apt to regard it at present in a passive way, and not to make use of it for enlarging his horizons and interests.

Allow me to enlarge a little more fully on the second and third reasons which I have given. Whatever pains the broadcaster takes to explain the difficulties of the wireless medium to a talker, it is exceedingly difficult for the average talker, especially those of the type mentioned, to assimilate the peculiar needs of this new form of expression. There is firstly the voice. Many speakers hardly yet seem to realize, obvious as it may seem when put down in the printed word, that this is their only medium of conveying their personality to the listener. It is impossible to interest any but the most highly-educated listeners in a subject unless an appeal is made to the emotions as well as to the mind. Secondly, many speakers do not pay special attention to the manuscripts from which they are going to talk. They not only write them out beforehand as an article, but they read them also as an article, and one can almost picture in one's mind's eye as the talk proceeds the punctuation of every sentence. And so, when a listener hears a series of sentences all heavily punctuated and read out in a flat, monotonous voice, he puts down his head-phones or shuts off the loud-speaker in disgust.

A Conversational Manner.

It is not so much the organization as the deliverers of talks who must be blamed for what lack of interest there sometimes is. On the whole, there is a vast amount of evidence from our correspondence that broadcast talks are coming into their own, and are awakening interests of all kinds, and that the broadcast talker is at last beginning to see the necessity of talking to the average man and woman as though he were having a conversation with them by their own fireside. It is the confidential, conversational manner which makes its immediate effect upon the listener. Two admirable examples of talkers who really understand the needs of the wireless medium are Sir Oliver Lodge and Sir Walford Davies. By speaking in an informal, natural way, by repeating sentences in order to emphasize their points, by lowering or raising their voices at the appropriate moment, they have managed to convey understanding of abstruse matters in science and music respectively.

A few words about the third factor, namely the listener. Inability to concentrate on anything of a serious nature appears to be one of the failures of the modern age. This would form an interesting psychological investigation of a general nature with which it is not within my province to deal, but I would modestly emphasize the need for the listener to help on the progress of broadcasting by making not only an endeavour to listen even to those talks which do not interest him with their first few sentences, but also to make a point of following up any series of talks that appeal to him by reading literature in connection with them. It seems to me that in this new medium of expression created by broadcasting we each of us have an opportunity of enlarging our minds by the stimulation of some of the foremost minds of the day speaking to us in the quiet of our own homes, and that any individual who shuts his ears to the messages of these men and women, is losing much that modern

life with its myriad activities in research, adventure and discovery offers to him.

School Transmissions.

A syllabus of school transmission during the summer months has now been issued and this indicates that the London school transmissions include series of talks on Mondays by Mr. E. Kay Robinson, whose animal talks have endeared him to countless young persons, on "Reptiles and their Allies"; on "Elementary Music and Musical Appreciation" by Mr. Cyril Wynn, H.M.I., and Sir Walford Davies; on "Citizenship" by Sir Stanley Leathes, K.C.B., First Civil Service Commissioner; twelve short studies of "Shakespeare's Heroines," by Mr. J. C. Stobart, Director of Education to the British Broadcasting Company, and Miss Mary Somerville; and on "Elementary French" by M. E. M. Stéphan, Lecturer on Phonetics at the Institut Français. The school concerts, organized by the People's Concert Society, will also continue to be relayed on Friday afternoons.

The main and relay stations offer a wide variety of fare to school listeners in the afternoons, details of which it is impossible to include within the limits of these notes, but which will be found in the syllabus.

Book Reviews.

A Chapter in the Early Life of Shakespeare: Polesworth in Arden. By ARTHUR GRAY, M.A., Master of Jesus College, Cambridge. (Cambridge University Press. *7s. 6d.*).

Horatio.—'Twere to consider too curiously, to consider so.
Hamlet.—No, faith, not a jot: but to follow with modesty enough and likelihood to lead it."

Not satisfied with the ordinarily accepted tradition of Shakespeare's stunted education at Stratford, and yet equally unwilling to accept the Baconian faith or the scepticism of Sir George Greenwood, the Master of Jesus College has set himself the interesting task of filling in part of the blank period in the history of the poet's youth. His method is a simple one: "If Shakespeare be allowed to speak for himself, he will tell us a good deal about Warwickshire . . . and, unconsciously, something about the conditions of his early life." Briefly, it is suggested that Shakespeare spent part of his boyhood as a page at Polesworth Hall in Warwickshire, the home of Sir Henry Goodere and the resort of a number of distinguished writers.

That traditional views of Shakespeare's boyhood at Stratford are almost entirely based upon conjecture is not disputed, but it is certain that he was referred to contemporarily as "gentle Shakespeare." "Gentleman," Mr. Gray comments "—one who has the essential marks which should distinguish birth and breeding. One thinks of the woolman's shop and that 'brute part' of calf-killing; and one wonders." The Stratford theory centres round the story of the deer-stealing incident, according to which young Shakespeare was "whipt and sometimes imprisoned" by Sir Thomas Lucy of Charlecote, near Stratford, who in revenge was immortalized by the poet as Justice Shallow in "Merry Wives of Windsor." "Apart from the not irrelevant fact that Sir Thomas had no deer park at Charlecote or anywhere else," says Mr. Gray, one may well ask "how Shakespeare came to drag this incident by head and ears into 'Merry Wives' and immediately to drop it." The ultimate source of the story is a manuscript note written by a Gloucestershire parson—William Fulman—who died in 1688; this note, added to by subsequent "biographers," was at length included by Rowe in his "Account of the Life of Shakespeare" issued in 1709, in which he recorded that the poet had given Justice Shallow "very near the same coat of arms which Dugdale in his antiquities of that county (Warwick) describes for a family there." Rowe, however, incorporated the opinions of the actor Betterton, a Shakespeare enthusiast who himself wrote for the stage "A Sequel of Henry IV, with the Humours of Sir John Falstaffe and Justice Shallow," and whose "visit to Stratford was, no doubt, prompted by the account and picture of Shakespeare's monument given in Dugdale's book, and the same book depicts and describes the Lucy Arms at Charlecote. The Lucy and the Shallow coat being practically identical, what inference more natural than that Shallow dramatically *is* Lucy?"

It is reasonable to suppose that Shakespeare would have alluded to the scenes of his boyhood at Stratford; he makes no single reference and even makes Shallow a *Gloucestershire* justice. He appears to have been unfamiliar with the Stratford-London road, as in the first part of "Henry IV" Falstaff does not take the direct way by Stratford, but makes a wide detour through northern Warwickshire. "If only Shakespeare had willed that Falstaff's ragged prodigals should take the Stratford road, what a chance he had for local scenes and characters!" . . . "And Shakespeare, who to a London audience presented that 'jest unseen, inscrutable' about Lucy of Charlecote, missed the obvious opportunity and that poor place, Sutton Coldfield, not native Stratford, had the glory of beholding Falstaff in the flesh." Such arguments are really convincing; but it is not easy to feel so confident as to go to the extent of saying with Mr. Gray, in describing the everyday life of the Stratford streets: "In that lively scene there is as little chance of detecting the poet-dramatist as there is of discovering a portrait of Milton in a Teniers group of drinking boors."! In Shakespeare's day patronage was the almost invariable prop of needy authorship. This commonly took the form of pageship in the service of wealthy patrons, and Chaucer and Sir Thomas More were among those who received early assistance in this way. John Shakespeare held the office of High Bailiff—corresponding to that of Mayor—in 1568-9, and in September 1571 he was elected Chief Alderman of Stratford. Just about this time, a dispute between a townsman and the Corporation was submitted to the arbitration of four county gentlemen—among them being Henry Goodere of Polesworth. According to the Minutes and Accounts of the Corporation of Stratford-upon-Avon, 1533-1620, the arbitrators gave their award at Stratford on January 3, 1570-1, and were entertained by the Corporation at the Bear Inn in Bridge Street. John Shakespeare is recorded as being a regular attendant at the meetings, and Mr. Gray supposes that as a result of this and other acquaintances with Mr. Goodere—twice in the accounts of 1571-2, the Cor-

poration paid for horse-hire to "Mr. Gooderes"—"little William was packed off to Polesworth." "'A guess,' it will be said" Mr. Gray admits, but it is a guess with a circumstance.

Mr. Gray's "case" for Polesworth must be read in full to be appreciated; suffice it to mention that Shakespeare is taken as referring to his boyhood in several of his earlier plays, and that a school certainly existed under the patronage of Sir Henry Goodere at Polesworth. This had previously been a school conducted at Polesworth Abbey, and mixed classes were taught there, which was not then the case at the Corporation schools such as that existing at Stratford; and it is significant that Holofernes in "Love's Labour's Lost" taught girls as well as boys. Part of the monastic buildings is preserved at the present time, notably the Gatehouse Range, in the upper floor of which the room is still to be seen that "conjecturely may have been the very scene of Shakespeare's schooling." Both because of the interest of new theory it advances and for its convincing exposure of much of the legendry attaching to the poet's boyhood, this book should certainly be read by every student of Shakespeare; and it will afford a fascinating hour to the general reader.

The Sacred Giraffe. Being the second volume of the posthumous works of JULIO ARCEVAL. Edited by SALVADOR DE MADARIAGA. (Martin Hopkinson & Co. Ltd. 1925 10*s.* 6*d.*).

The fiction of futurity has been greatly enriched by this entertaining glimpse of a negro civilization that flourishes in the 70th century, and provides a gifted Spanish writer with a theme for a most entertaining satire on archaeology and politics. The Ebonite nation, its folklore, social organization, human values and intelligentza are discussed with something of the calm, impersonal irony that Anatole France brought to "Penguin Island"; and with humour that is never forced and the rare literary skill that invests the most bizarre conceptions with an air of convincing reality, this strange civilization is brought to life. The Ebonites are dominated entirely by women, men being regarded as the fair and fascinating sex, and they are left to their athletics and games while women get on with the serious work of the world; and this inversion escapes the hackneyed features that usually accompany such predictions of triumphant feminism, perhaps because the author has no propaganda axe to grind. The conclusions of the Ebonite *savants* regarding the long-dead white civilizations of Europe and America are based on very meagre data; they have an Eno's fruit salt bottle, the covers of "The Oxford Book of English Verse," and one or two posters, and here and there some fragment of a record, hesitatingly translated and badly misunderstood. Quite one of the pleasantest conceits in the book is the Ebonite belief in the profound immorality of statistics, on the assumption that "the spirit that counts is the true enemy of the spirit that creates."

J. G.

The Personal Equation. By LOUIS BERMAN, M.D. (George Allen & Unwin Ltd. 8*s.* 6*d.*).

The author holds the comforting theory that most of our shortcomings and some of our genius are due to a lack of balance in the functioning of the ductless glands. One may be a perfect martyr to an idle suprarenal or a too zealous pituitary. It is, he holds, the clue to why one person becomes a millionaire and another merely figures in the Newgate Calendar.

There is something to be said for the theory, though the somewhat broad claims made by the author want a moderate rather than a too credulous acceptance. The popular exposition of medical theory is all to the good provided that the layman, like the medical practitioner, does not accept it as gospel until it has been proved. Gland therapy with the possible exception of thyroid extract is not as popular as it was a few years back, and it may be long before we are able to stimulate or depress at will many of these important centres.

The book is entertaining and challengingly written. The argument carried to its logical end reduces much that we class as psychology to a mere gland secretion. Thus, if you are bored with having an inferiority complex you can change from psychology to plain physiology, and complain that you are an adrenal subject. The book will fill a useful purpose in directing attention to a field of work where rich returns may be expected.

The Engineer and the Prevention of Malaria. By HENRY HOME, M.Inst.C.E. (Chapman & Hall Ltd. 13*s.* 6*d.*).

This is an engineer's book on malarial problems, but the author, Mr. Home, shows a very clear conception of the biological aspect of the problem. Of course, he is in the main interested in schemes for draining the waters where mosquitoes breed, and he has written a book which will be of the greatest use to those who are responsible for clearing a district of malaria. Problems of drainage are treated with great detail, and in many cases are the result of personal experience. There are many side issues in clearing away mosquito larvae, and a particularly troublesome example is the presence of water plants. The water-hyacinth, which has been introduced from Brazil throughout the tropics, is a serious problem. Various methods with varying degrees of success are recorded in dealing with the water-weed "friends" of the Anopheles larvae. The formation of marshes is another cause of trouble.

There are in the treatise a couple of good figures of fish which are useful in destroying the larva under natural conditions. But the fishes cannot destroy the larvae which are saved by the protection given by beds of water vegetation, especially by plants with leaves just below the water surface.

The protection of houses and other quarters forms a most useful chapter, and the figures and description of various cotton netting, screen cloth, and mosquito wire netting are unusually full. This forms Appendix No. 1, and is contributed by Colonel W. P. McArthur, D.S.O., M.D., of the R.A.M.C.

The figures are on the whole good, but the photographs on the shiny paper between pages 12 and 13 and 14 and 15 show little detail, and would have been clearer had they been sketches. Altogether the book is likely to be of great value throughout the malarial districts of the world.

A. E. S.

Euterpe, or the Future of Art. By LIONEL R. MCCOLVIN. (Kegan Paul. 2*s.* 6*d.*).

Art, so far as the layman is concerned, usually means pictures. Hogarth, Gainsborough, Constable, and of yesterday, Sargent, stand out among painters whose work is paramount. Yet for a decade we have been told to seek beauty in dyspeptic colour, in maniacal distortion of form, and in lie in line, colour and structure. The nebulous, the infantile, and the negroid have all been hailed as revelations, but the public as a whole have shown mistrust. A sound and healthy instinct has killed the market for bogus art. Warehouses of Futurist, Cubist, Vorticist, Tottenham Court Road and King's Road art are on the dealers' hands. Caught by the slump, the commercial highbrow still endeavours to dispose of the rubbish by suggesting that the public is not a good judge of art. The ethnologist

and the anthropologist, which are the branches of science which come nearest to a scientific knowledge of that nebulous quantity art, know full well that true art is always a factor of its time and people, and not a crazy alien novelty imposed by the hack dilettante on the people. The average judgment of the people is far sounder than these self-appointed heralds would have us believe. The future of art is after all in the hands of the people. and the real artist need not fear that in the end accurate judgment will not be passed. For the present there is little hope for him until some of the people who write about art are dead. In the meantime buy what you enjoy and you will be right.

Applied Chemistry. Volume II: "Foods." By C. Kenneth Tinkler, D.Sc., and Helen Masters, B.Sc. (Crosby Lockwood. 15*s*. net).

This book is written to serve the needs of the degree of B.Sc. in Household Science granted by the University of London, and is suitable for students of public health. A book on the chemistry of food offers opportunity, for anywhere else except in Britain cooking is a recognized art. Here, apparently, we class it as a science, and earn the derision of the world. The book appears to be a perfectly sound chemical manual entirely suitable for laboratory work and unhindered by any thought of the kitchen or the household. It does not mention onions.

An Introduction to Industrial Chemistry. By S. I. Levy, M.A., F.I.C. With an Introduction by Sir William Jackson Pope, K.B.E., F.R.S. (G. Bell & Sons. 15*s*.).

The student of chemistry will welcome this little book which, although containing an exhaustive summary of most of the applications of chemicals in industry, is not in a true sense a textbook. The author introduces the student to the elements of economic process—such matters as stock sheets, services, tables, and other basic factors highly esteemed in the works but never heard of in the laboratory. The book is a useful link between the academic and the real world. Sir William Pope's introduction hammers in the hard fact that the young chemist is, when all is said and done, an industrial worker and wage-earner, and that a halo of knowledge is valueless to a capitalized concern unless it is economically productive. In Russia the chemist is paid less than a workman, and it is time that scientific workers as a whole revalued and determined their true status, for technology and manufacture are industries—and the way of the world is hard. There is no false glamour about this book.

Pleasure and Pain. By Paul Bousfield, M.R.C.S., L.R.C.P. (Kegan Paul. 4*s*. 6*d*.).

This little book is an elaboration of Dr. Bousfield's theory that pain is an affect accompanying tension, and that pleasure is an affect "which results in the conscious animal as a result of the discharge or neutralization of tension." This theory is almost identical with that already enunciated by Professor Freud, and the difference, which is discussed by Dr. Bousfield, does not seem very important. But Dr. Bousfield is interesting and stimulating for the suggestion that we habitually excite in ourselves a state of tension and relative discomfort with the unconscious motive of enjoying the subsequent relaxation, and that we enjoy the tension by anticipating, in imagination, the pleasure to come.

It is unfortunate that Dr. Bousfield, possibly with the laudable intention of being clear and simple, dismisses from consideration those forms of pleasure such as the enjoyment of a pleasant flavour, certain aspects of natural beauty, etc., which are not easily explicable by his theory, for it gives the impression that the vexing problems of aesthetics have here been finally and simply resolved. The author attributes our enjoyment of the beauty of the sunrise to a pleasurable anticipation of the warmth of the risen sun; it is, perhaps, characteristic of the author's method that he leaves the beauty of the sunset unexplained.

The book is written with a minimum of technical terms and helpfully illustrated with simple diagrams.

F. A. Hampton.

Arabian Medicine and its Influence on the Middle Ages. By Dr. Donald Campbell. Two volumes. (Kegan Paul. 21*s*.).

It is only in recent years that scholars have begun to realize the true value of the Arabic or Saracenic influence on European learning from the seventh century onward. It is not so much that the Arabian scholars were originators, although their contributions in many branches of knowledge are noteworthy. Their true value though was to keep alive the traditions and remnants of Hellenic knowledge. They are as it were the temporary rallying point and bridge-head from which old knowledge was again released when the Dark Ages of Western Europe began to clear away. In our picture of Western Europe we see little but the knight and man-at-arms and the Gothic age of faith and superstition. Religious philosophy flourished, but there was no trace of science or even a tend toward scientific thought. Europe was sterile. Yet the seed was there. The oriental physician, philosopher, and alchemist had preserved for us the basic knowledge of Greek medicine.

Dr. Campbell's scholarly work summarizes a vast amount of research. His hero is Claudius Galen (131-210), father of practical anatomy and the most important influence on the development of medical knowledge for many centuries. Arabian medicine is to all intents Galenism, and both Arabian and later Hebrew texts are in the main from Galenical MSS. The tradition endured long and did not yield to the slow march of progress until well into the seventeenth century, when the new learning based on experiment rather than blind tradition shaped the beginnings of modern science.

The second volume is a very wide index of known Galenica MSS. in Latin translations, and a bibliography. The whole book is a very remarkable piece of specialized work, and a valuable contribution to our knowledge of the early history not only of medicine but of the natural philosophy of the early periods.

Bedouin Justice. By Austin Kennett. (Cambridge University Press. 7*s*. 6*d*.).

Any book on law is supposedly dull, but this book is a sheer delight to read. The author, an administrative officer in the Libyan Desert, has made a study of the Bedouin from the tribal point of view. Of course, it is the only point of view which makes his actions and his rule of life even moderately comprehensible to Westerners, but it is customarily neglected not only by Europeans but also by the town native and Egyptians. The book is written in admirable style and with a delightful sense of humour. It is an excellent study of the Bedouin, and shows that he is not the feckless robber that the Egyptians believe, nor is he the slushy hero of suburban sex fiction.

In addition to being astoundingly interesting, the book is a very valuable manual for those who may have to deal with these people. Actual lawsuits are described and custom and native law bearing on the specific cases is discussed. One gathers that on the whole Bedouin law operates fairly well, and suits the people and the mode of life of the country. The conditions of evidence, the payment of blood moneys, and the

assessing of fines in camels are gone into and the reader gathers a striking picture of a system which is efficient in its mechanism for dealing with cases where Western law would be powerless or unjust. Strongly recommended to the general reader.

Proctor's Half-hours with the Telescope. Revised by Dr. W. H. Stevenson, F.R.A.S. (Longmans, Green & Co. 5*s.*)

The new edition of this old favourite has been brought up to date as regards the astronomical sections. The introductory matter on the telescope, which is important to the beginners for whom this book is written, is scanty, and confined in the main to the refractor of small aperture. Reflectors are more or less neglected.

Stereoscopic Photography. By Arthur W. Judge. (Chapman & Hall Ltd. 15*s.*).

The literature of stereoscopy has been neglected in late years, and its undoubted advantages as an educational medium have been overlooked. Stereo-cameras are no longer made in England and the hobby is practically limited to the Continent. The applications of stereoscopy are, however, important in X-ray practice, in aerial reconnaissance, and in such subjects as the teaching of anatomy. A revival of this form of photography is not to be expected, as the whole tendency of modern life is toward simplification of process and the stereogram, involving a special appliance for viewing it, is not popular. The author indicates some of the conventional applications of the binocular principle in microscopes and instruments, but it appears that the stereoscopic cinema needing no special viewing appliance is yet to come. Until it does we fear that interest in stereoscopy will be limited to the few. H. B. C. P.

The United States as a Neighbour. By Sir Robert Falconer, K.C.M.G. (Cambridge University Press. 7*s.* 6*d.* net).

The Dominion of Canada, now "on its own," has had an uneasy childhood. The average history book reflects little of Canadian history since the death of Wolfe, and it is a matter for congratulation that this is so. The longest unprotected land frontier in the world gives the least cause for uneasiness, and provided that our home politicians do not sink to even greater inefficiency or no typhoon of corruption sweeps the western hemisphere, Canada is likely to remain in the Empire. This book gives a sound and well-balanced review of the history of that nation in its relations with the neighbouring republic. Both peoples have much in common, but there are still enormous differences in outlook. The States may be envious of Canada, but the Canadian is not convinced that even if he would be more prosperous under the Republic, such prosperity would not be at the cost of material sacrifices as well as the abandonment of ideals. That two great nations can live side by side in amity is the lesson of the Canadian frontier, and it is not until one reads this book that one remembers how often in earlier days the utmost resources of diplomacy were engaged to preserve the peace. The President of the University of Toronto deserves the gratitude of both nations for this very able series of lectures. J. McA.

The Basis of Modern Atomic Theory. By C. H. Douglas Clark, B.Sc., D.I.C. (Methuen. 8*s.* 6*d.* net).

The outstanding feature of this book is the detailed biography at the end of chapters. This makes it exceptionally valuable as a quick reference to original papers. It is rather too technical for popular reading, but well adapted for supplementary study by fairly advanced students.

The Discovery Book Club.

The *Discovery* Book Club is a co-operative effort to increase the supply of books available to readers. The enterprise was inaugurated last month and, as then anticipated, it is in connection with second-hand books that its co-operative arrangements are most appreciated. While there are ample facilities for the circulation of popular fiction and literature—with which the Club does not therefore concern itself—every student is faced with the loss that always occurs in the haphazard disposal of his surplus books. By bringing supply and demand into direct relation *Discovery* will hope to benefit both buyer and seller.

All postal subscribers to *Discovery* are entitled to membership, and can open an account with the Book Club on the understanding that bills are payable quarterly. On sending a first notification of books wanted or for sale, a subscriber automatically opens an account with the Club. All trouble in remitting cash with each order will thus be avoided, as the Club will simply debit the buyer and credit the seller in the Club accounts. New books will be charged at the published price, post free; and second-hand books at the seller's price, plus sixpence for expenses.

All other regular readers of *Discovery* are also entitled to membership, but on the condition that every book is paid for in cash at the time of purchase.

In sending notices of books wanted and for sale a member should state that his name is already on the *Discovery* postal subscription list, or that he is a regular reader of *Discovery*, or should enclose one year's subscription to *Discovery*.

Members undertake in offering books for sale that these are in good condition. Damaged or defaced copies will not be entertained. In every case the price that the member is prepared to pay, or the lowest price that he will accept, should be stated. In pricing a second-hand book the figure should seldom be more than half the published price for a book in really good condition; if old, one quarter to one-fifth original price.

The Club having instructed one member to forward a book to another member requiring same, it will be deemed that after five days a contract has been made, unless within that period the book be returned as in an unsatisfactory condition and the Club notified accordingly. When a non-subscriber is informed that a book required is at his disposal, he will forward payment to the Club, which will then instruct the seller to dispatch the book to him. In every case cash will then be credited to the seller's account, and settlement will be made quarterly by the Club. If a book is returned as unsatisfactory, the Club will debit the purchaser with a charge of sixpence for expenses.

The Club cannot undertake to enter into correspondence with members, its business in general being conducted on forms, and reserves the absolute right to refuse business in such cases as it may deem desirable. A list of books wanted by members is published in the small advertisement column on another page, and readers able to supply these are invited to communicate with *Discovery*.

We are informed that Professor Brouwer's "Practical Hints to Scientific Travellers," published by Martinus Nijhoff, of The Hague, and reviewed in our March issue, can now be obtained from Messrs. W. & G. Foyle Ltd., of Charing Cross Road, W.C.2, who are the British agents for this book.

b.

crease
erprise
t is in
range-
cilities
which
ent is
sposal
l into
seller.
ership,
under-
ing a
auto-
ple in
e Club
Club
price,
, plus

ed to
id for

ember
postal
overy,

are in
enter-
pared
tated.
more
ition ;

ook to
after
period
d the
ormed
rment
h the
o the
y the
o will

dence
orms,
cases
mbers
nother
nicate

tical
cinus
arch
Toyle
the

M
A
Y

2
6

XU